RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

Vol. 59 DECEMBER, 1952 No. 6

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RADIOLOGY

A MONTHLY PUBLICATION DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

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PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

Vol. 59 December, 1952 No. 6

Roentgenologic Manifestations of Vitamin D Intoxication[1]

COLIN B. HOLMAN, M.D.

Rochester, Minn.

THE ROENTGENOGRAPHIC appearance of certain lesions associated with the prolonged and excessive use of vitamin D preparations of high potency has been referred to in many previous publications (1–4) and has been described in detail in an excellent review of the subject by Christensen, Liebman, and Sosman (5). The changes usually described include abnormal periarticular deposits of calcareous material and the absorption of bone, which is usually referred to in the roentgenologic literature as generalized osteoporosis. Because these lesions have been discovered in a relatively small number of patients who have ingested vitamin D in massive doses, the present study was undertaken to determine, if possible, what other pathologic or physiologic factors may contribute to their production.

MATERIAL STUDIED

A review was made of the clinical records and of all the available roentgenograms of 56 patients in whom a diagnosis of vitamin D intoxication was made at the Mayo Clinic. The clinical diagnosis in each instance was based on a history of ingestion of huge amounts of potent vitamin D preparations for prolonged periods, the development of the symptoms of vitamin D intoxication following use of the drug, and the disappearance of these toxic manifestations after its withdrawal in those cases in which subsequent follow-up information was available.

The patients of this series experienced the symptoms of vitamin D intoxication which have been described in many previous publications (4, 6–15). Those associated with the gastrointestinal tract included anorexia, nausea, vomiting, pain in the abdomen, epigastric distress, diarrhea, loss of weight, and the sensation of an unusual taste in the mouth. Symptoms referable to the urinary tract were frequency, nocturia, polyuria, polydipsia, and urgency. There were also symptoms referable to the central nervous system, such as headache, drowsiness, dizziness, and haziness of memory. Pruritus was also of frequent occurrence.

All available laboratory data were tabulated in each case. Those referable to the chemical constituents of the blood included the concentrations of calcium, phosphorus, urea, creatinine, uric acid, sulfate, serum protein, and acid and alkaline phosphatases. Other examinations of the blood included erythrocyte and leukocyte counts, determinations of the concentration of hemoglobin, and the erythro-

[1] From the Section of Roentgenology, Mayo Clinic, Rochester, Minn. Presented at the Thirty-seventh Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1951.

Abridgment of a thesis submitted by Dr. Holman to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Radiology.

cyte sedimentation rate. Urine had been tested for specific gravity, reaction, relative concentration of albumin, and the presence of erythrocytes and leukocytes. In some instances the amounts of calcium and phosphorus excreted during twenty-four hours were measured. The Sulkowitch test had been applied to the urine in some instances.

All of the available roentgenograms of these patients were reviewed, and the following information was tabulated in each case: the presence or absence of roentgenologically demonstrable osteoporosis in each portion of the skeleton so examined, the presence or absence of abnormal deposits of calcareous material, and the type of any accompanying arthritic process.

DEFINITIONS

The term "metastatic calcification" has been applied to the lesions produced by the abnormal deposition of calcium salts which occurs concurrently with skeletal decalcification, as in osteomalacia (16). For convenience in consideration of the abnormal calcification resulting from excessive use of vitamin D, the lesions are subdivided in this presentation into three types of calcification which appear to have certain differences in pathogenesis. These will be referred to as physiologic, vascular, and pathologic types of metastatic calcification. While this subdivision may seem somewhat artificial, it is thought to be helpful in the evaluation of roentgenologic manifestations of vitamin D intoxication.

In this paper physiologic calcification is considered to be that type which was called "metastatic calcification" by Mulligan (17), who presented the first comprehensive review of the subject. He stated that this type of calcification is "...a condition in which calcium salts are deposited in tissues previously normal but with a tendency toward alkalinity." These tissues include those which excrete acid and are thereby rendered alkaline, such as the mucosa of the stomach, the tubular epithelium of the kidney, and the pulmonary tissue. Many authors have reported that deposits of calcium salts have been produced in these tissues in experimental animals by the administration of excessive amounts of vitamin D (4, 7, 8, 14, 18–25).

Vascular calcification likewise has been produced in experimental animals with vessels presumably normal before the administration of the drug (8, 21, 22, 24, 26–35). The media of such vessels is said to have become altered as a consequence of the administration of the drug, and this change in the tissue is followed by the deposition of calcareous material within the vessel walls (22, 32, 36).

In pathologic calcification, deposits occur in tissues that are thought to have become abnormal as a result of certain disease processes before the deposition took place. This calcification may affect the periarticular tissues, the regions of various bursae, and rheumatoid nodules.

All of these general types of deposition of calcium salt may accompany the excessive administration of vitamin D. However, there is probably a difference in the development of each type, thus indicating the existence of some factor or factors not common to all.

RESULTS OF STUDY OF 56 CASES

Data were correlated with the age and sex of each patient, the dosage schedule and the total dosage of the vitamin D product used, and with other coexisting clinical diagnoses. It is not possible from such a study to determine the relative incidence of hypervitaminosis D nor to determine the dosage schedule necessary to produce this disorder, since many persons apparently tolerate huge amounts of vitamin D without any obvious ill effects (13). All of the patients in this selected group had evidence of some impairment of renal function as judged by the presence of albumin in the urine or a concentration of urea in the blood of 40 mg. per 100 c.c. or more.

Of the 56 patients in this series who had clinical and laboratory evidence of vitamin

D intoxication, 20 had no roentgenologically demonstrable osteoporosis (Table I). In 23 patients (41.1 per cent) osteoporosis was demonstrated in some but not all of the roentgenograms, and in 13 (23.2 per cent) it was apparent in all of the roentgenograms.

TABLE I: OSTEOPOROSIS AND VITAMIN D INTOXICATION

	Cases
Total cases in study	56 (100.0%)
No demonstrable osteoporosis in any roentgenogram	20 (35.7%)
Demonstrable osteoporosis in some but not all roentgenograms	23 (41.1%)
Demonstrable osteoporosis in all the roentgenograms	13 (23.2%)

The roentgenograms of all patients who had evidence of rheumatoid or gouty arthritic processes showed some osteoporosis. This condition is anticipated in patients with such disabilities. It is difficult, however, to assess the extent of the osteoporosis which is due to removal of calcium salts from bone as a result of the action of vitamin D and that which may be attributed to senile or endocrine changes, disuse, and other causes of the absorption of bone. It seems evident that, although vitamin D when administered in massive doses undoubtedly does enhance the loss of calcium salts from the skeleton (10, 37), this depletion is not always easily detected by roentgenographic methods.

TABLE II: VASCULAR CALCIFICATION AND VITAMIN D INTOXICATION

	Cases
Total cases in study	56 (100.0%)
No vascular calcification demonstrated	38 (67.9%)
Vascular calcification demonstrated	18 (32.1%)
Patients 50 years of age and older	15
Patients less than 50 years of age	3

Although physiologic calcification has been produced experimentally in animals by the administration of excessive amounts of vitamin D, there was no roentgenographic evidence of calcareous deposits in the lungs, stomach, or kidneys of any of the 56 patients of this series who had vitamin D intoxication.

Evidence of vascular calcification was found in the roentgenograms of only 18

TABLE III: PATHOLOGIC CALCIFICATION AND VITAMIN D INTOXICATION IN 8 OF THE 56 CASES IN STUDY

Case	Sex and Age	Blood or Serum, mg. per 100 c.c.			Urine		Other Diagnoses	Site of Deposits	Vitamin D*	
		Ca	P	Urea	Sp. Gr.	Albumin (grade)			Daily†	Duration (yr.)
1	M 61	12.2	5.2	106	1.009	2+	Rheumatoid arthritis	Both feet	300	14
2	F 43	10.4‡	6.1	116	1.011	2+	Gout, obesity, hypertension, diabetes mellitus	Right elbow	137	1½
3	M 63	12.8	5.8	110	1.010	1+	Rheumatoid arthritis	Right wrist; left shoulder; left foot	250–300	5
4	M 63	10.9‡	5.2	116	1.010	1+	Gout	Both feet; both hands; ischial bursae	150–800	2
5	M 63	13.9		96	1.011	1+	Rheumatoid arthritis	Right hand	"Large doses"	1
6	F 21	12.7	4.6	32	1.007 Fixed	2+	Rheumatoid arthritis	Right elbow; both hips; left wrist; left ischial bursae; other bursae	50	3
7	F 50	10.9‡	5.0	114	1.010	2+	Rheumatoid arthritis	Right knee	150–300	½
8	F 35	13.8	4.8	88	1.007	1+	Rheumatoid arthritis	Right foot; left elbow	200	4

* Ertron was taken in Cases 1, 2, 4 and 8; Ertron and other products in Case 3. Data concerning product not available for Cases 5, 6, and 7.
† Dosage in International Units × 1000.
‡ Determinations made after withdrawal of vitamin D medication.

Fig. 1. Case 8, Table III. Destructive rheumatoid arthritic changes in right hand and wrist with periarticular putty-like calcific deposits. The patient was a woman thirty-five years old.

(32.1 per cent) of the 56 patients (Table II). Inasmuch as all but 3 of these patients were more than fifty years of age, it is doubtful whether one may properly ascribe this deposition of calcium in the walls of blood vessels to the effect of hypervitaminosis D alone, although it cannot be denied that the presence of vitamin D may have enhanced the process. Of the 3 patients less than fifty years of age who showed some roentgenologic evidence of vascular calcification, 1 was a woman of forty-eight years and 1 a man forty-four years of age. Vascular calcification is not uncommon in individuals of this age group. The third patient was a young woman of twenty-six years. Roentgenograms of the pelvis and lumbar vertebrae in this case showed evidence of rather marked vascular calcification which ordinarily would not be found in a person of this age. It is possible that the excessive intake of vitamin D may have contributed to the production of this calcification. Such vascular calcification, however, has been reported in even younger persons who have not ingested massive doses of vitamin D (38). These data indicate that, although hypervitaminosis D is undoubtedly associated with the production of vascular calcification, the presence of this type of calcareous deposit is by no means a pathognomonic roentgenographic indication of vitamin D intoxication.

The roentgenograms of 8 patients (14.3 per cent) of the series showed evidence of pathologic calcification (Table III). This group of patients is of particular interest because, in addition to exhibiting that peculiar type of calcification of the periarticular tissues or bursal sacs previously described by others as being associated with hypervitaminosis D, each patient had evidence of renal insufficiency and advanced rheumatoid or gouty arthritis. All except 1 of these 8 patients also had an elevated concentration of phosphorus in the serum because of renal insufficiency. The concentration of serum phosphorus of this patient (Case 5, Table III) was not measured. Six of these 8 patients had rheumatoid arthritis and 2 had gouty arthritis. These conditions did not coexist in any of the remainder of this series.

Three types of pathologic calcification were discovered on examination of the roentgenograms of these patients. The first and most common was the putty-like deposit of material containing calcium in the periarticular tissues of joints which were involved in the rheumatoid or gouty arthritic process.

Such deposits were usually lobulated, coalescent masses with a roentgenographic density ordinarily attributed to deposits containing calcium. They usually had smooth outlines, and accumulations of such deposits sometimes presented an appearance resembling a "bunch of grapes." This type of periarticular calcification was apparent to some extent in the roentgeno-

grams of all 8 patients who had pathologic calcifications. An example in the right wrist and in several of the metacarpophalangeal joints of the right hand of a women thirty-five years of age (Case 8) is shown in Figure 1.

An example of this second type of pathologic calcification is demonstrated by Figure 2, which shows the pelvic region of a woman twenty-one years of age (Case 6) who had severe rheumatoid arthritis involving almost all of the peripheral joints.

Fig. 2. Case 6, Table III. Putty-like calcific deposits in bursae overlying various bony prominences.

The second type of pathologic calcification resembled the first except that it was located in the bursal sacs or in rheumatoid nodules rather than in the periarticular tissues. Two of the patients in this group (Cases 4 and 6), one of whom had rheumatoid arthritis and the other gouty arthritis, exhibited this type of deposit in the subischial bursae. This type of deposit has been described before (5), and its appearance is similar to that of the periarticular deposits just considered. It presumably develops within a synovium-like structure and may be a variant of the first, possibly resulting from similar pathologic and physiologic conditions.

Her disease had been active for three and a half years. There were deposits in the region of the left subischial bursa and in the soft tissue adjacent to the greater trochanters, head of the left femur, the anterior iliac spines, the crest of the left ilium, and over the sacrum. These deposits are thought to have developed within bursal structures over various bony prominences and within rheumatoid nodules. Many of these lesions broke down and exuded a white semisolid material resembling tooth paste.

The third type of pathologic calcification was associated with tophaceous gout. Two patients (Cases 2 and 4) had exten-

Fig. 3. Case 4, Table III. Putty-like calcific deposits associated with less dense granular calcification of tophi in the right hand of a patient with gouty arthritis.

sive disease of this type. Dense deposits containing calcium were found in the regions of the tophi, the calcium probably having been deposited with or around urate deposits.

Figures 3 and 4 show this type of pathologic calcification as observed in the right hand and right foot of a man sixty-three years of age (Case 4) who had had tophaceous gout for thirty-five years. His left hand and left foot showed similar calcareous deposits. In addition to the putty-like deposits similar to those demonstrated in Figure 1, there were extensive granular deposits containing calcium which are thought to be associated with the pre-existing tophi.

Figure 5 shows extensive calcification

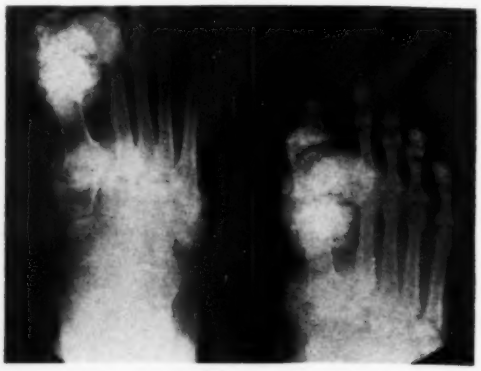

Fig. 4. Case 4, Table III. Right foot of a patient with gouty arthritis showing putty-like calcific deposits with less dense calcification of tophi.

within the soft tissue of the extensor surface of the right elbow and forearm of a woman forty-three years of age (Case 2) who had had tophaceous gout for thirteen years. These deposits were apparently associated with pre-existing tophi, and the same rough granular appearance as shown in Figure 4 is evident. The patient also had gouty arthritis of both hands, both shoulders, and both knees.

Fig. 5. Case 2, Table III. Extensive calcification within gouty tophi.

COMMENT

The relative significance of the recognition of the presence of osteoporosis and calcification of physiologic, vascular, or pathologic type in the roentgenologic diagnosis of vitamin D poisoning has been referred to in the presentation of the data obtained through a study of 56 cases of vitamin D poisoning. Although any of these changes may be associated with the excessive ingestion of vitamin D, only pathologic calcification appears to be sufficiently indicative of vitamin D poisoning to be of primary diagnostic significance. The roentgenographic appearance of these deposits, together with their association with rheumatoid or gouty arthritic processes, seems to be sufficiently unique and characteristic to render consideration of differential diagnostic possibilities virtually unnecessary. These deposits do not resemble the lesions of calcinosis universalis, calcinosis circumscripta, dystrophic calcification, myositis ossificans, or tumor calcinosis.

In a recently reported case, however, Oosthuizen and co-workers (39) described the presence of large, dense, smooth, well defined, amorphous calcareous masses closely related to the trochanters, elbows, and scapulae of a girl fourteen years of age. These resembled a bunch of grapes in outline. Investigation of the masses by the pathologist indicated that they were composed of calcareous material with definite evidence of degeneration of fatty tissue. There was no evidence of an arthritic change in the reproductions of the roentgenograms accompanying this report and there was no reference to the use of vitamin D. These calcific deposits closely resembled those shown in Figures 1 and 2. It is acknowledged that, until the pathogenesis of these lesions is completely understood, it is possible that lesions similar or identical to those attributable to hypervitaminosis D may be produced by some pathologic or physiologic process not associated with vitamin D. If this is true, such a process must be rare indeed.

The general effects of the administration of vitamin D in massive doses on the chemical constituents of the blood have been referred to (5), and this present study contributes no new information in this respect. It has yielded some information, however, relative to other factors associated with the development of pathologic calcification. The review of all 8 cases in which pathologic calcification occurred (Table III) revealed the following conditions:

1. There was a history of ingestion of massive doses of high-potency vitamin D preparation over a prolonged period of time. This, of course, is expected by the selection of cases.
2. There was clinical and laboratory evidence of renal insufficiency.
3. The concentration of phosphorus in the blood was abnormally high.
4. A rheumatoid or gouty arthritic process was present.

In 7 cases all four of these factors were present. Unfortunately, the concentration of phosphorus of the blood was not recorded in Case 5 (Table III), although all of the other factors were present.

In Table IV are tabulated the available data referable to 10 cases previously reported in the literature in 9 of which pathologic calcification was demonstrated. In all of these cases in which tests were made before withdrawal of vitamin D, these same four factors were present. In Case 5 of the series reported by Christensen and associates (5), pathologic calcification was not demonstrated. This exception, however, probably does not detract from speculation concerning the factors accompanying deposition of calcium salt, since in this case there was no evidence of pronounced renal insufficiency and the high concentration of phosphorus in the blood decreased to normal within two months following withdrawal of the drug.

More important is the observation that patients who have pathologic calcification about various joints have other joints apparently equally involved in the arthritic process but with no demonstrable

TABLE IV. PATHOLOGIC CALCIFICATION AND VITAMIN D INTOXICATION IN 9 CASES COLLECTED FROM THE LITERATURE; ABSENT IN TENTH CASE

Author	Sex and Age	Blood or Serum, mg. per 100 c.c.			Urine		Other Diagnoses	Site of Deposits	Vitamin D		
		Ca	P	N.P.N. or Urea	Sp. Gr.	Albumin (grade)			Approximate Daily Dose§	Duration (yr.)	Product
Danowski et al (40)	F 47	15.37	4.53	N.P.N. 67	1.013		Arthritis, 18 years	Ankles; wrists (P*)	150–450	6	
Bevans and Taylor (41)	F 63	13.0	6.0	Urea 58		+	Rheumatoid arthritis	Feet (P)	150–200	1½	
Kaufman et al (2)	F 63	14.7		N.P.N. 96 B.M.R. 58	1.012	2+	Rheumatoid arthritis	Feet; hands; sternoclavicular joint (P)	150–200	1¼	Ertron
Schneider and Kammer (4)	F 55	10.7	6.1	Urea 123	1.011	Trace	Rheumatoid arthritis	Shoulders; right hip (X*)	300 150	⅙ 1½	
Paul (12)	F 38	13.5	5.7	Urea 52	1.002	+	Rheumatoid arthritis	Fingers; toes; shoulders; neck; thigh (P)	100–150	1½	
Christensen et al (5)											
Case 1	F 62	9–16	6	N.P.N. 49			Rheumatoid arthritis	Shoulders; ankles; knees; elbows (X; P)	150–200	5	Ertron
Case 2	M 29	12.2	5.0	N.P.N. 76	1.005	2+	Rheumatoid arthritis	Below left ischial tuberosity; right greater trochanter, sacrum (X; P)	150	5	Gelatabs
Case 3	F 54			N.P.N. 79			Rheumatoid arthritis	Right hip; elbows (X; P)	100	2	Ertron
Case 4†	F 59	9.9	4.4	N.P.N. 32		1+	Rheumatoid arthritis	Hands; wrists	300	3	Gelatabs
Case 5	F 48	11.1	6.5‡	N.P.N. 37			Rheumatoid arthritis	0	50	1	Ertron

* P = Pathologic examination; X = Roentgenologic examination.
† Blood chemistry determinations made 9 mo. after withdrawal of the drug.
‡ Became 2.6 in 2 months.
§ Dosage in International Units ×1,000.

periarticular calcareous deposits. This observation appears to be of significance, because it indicates that a combination of the four factors mentioned is not sufficient in itself to initiate the deposition of these salts of calcium. It suggests that there must be, in addition, some local factor or factors altering the tissues. Activity of the arthritic disease process, trauma, and other causes might be postulated as being local factors of importance, but no definite information is available on this point.

An interesting avenue of speculation is suggested by data obtained from these cases, and this may warrant further investigation. There is as yet no satisfactory explanation of the formation of the tophaceous deposits of sodium urate in gout (42). Certainly the presence of a high concentration of uric acid in the blood is not a complete explanation, because this condition may be present in other diseases such as leukemia, hepatitis, etc., in which tophi are not demonstrable. Gout is usually considered to be due to some fault in metabolism. It has been suggested that a part of the process may be local excretion of uric acid by some cells with resulting precipitation of sodium urate crystals (42).

Sodium urate is a salt of a strong base and weak acid and thus might be expected to precipitate out of tissue fluids if there were a relatively alkaline reaction at a certain site of predilection. Similarly, calcium phosphate is a salt of a strong base and a weak acid and, when these ions are present in the proper concentrations, a shift of the *p*H of the local tissue fluids to a more alkaline reaction could initiate the precipitation of the salt (7, 43–45). This process is essentially the same as that frequently advanced to explain the precipitation of calcium phosphate in normal tissues rendered alkaline by the physiologic loss of acid, as in physiologic calcification (17). It may be, therefore, that some abnormal metabolic process alters the *p*H and in the presence of a high phosphate concentration in the blood initiates the precipitation of calcium phosphate in the periarticular, synovial, bursal sac, or other tissues. This process may be similar to that which initiates precipitation of sodium urate crystals in the tissues of persons who have gout. It is not to be implied that the processes in these instances are identical, but each of these diseases capable of producing this type of a destructive arthritic process may be associated with some similar error in the metabolic processes of these tissues. Beyond this suggestion, further speculation does not seem to be justified at this time.

SUMMARY AND CONCLUSIONS

A review of the clinical records and roentgenograms of 56 patients who had vitamin D intoxication was undertaken to determine the relative significance of the presence of roentgenologically demonstrable osteoporosis and abnormal deposits of salts containing calcium in the diagnosis of this disorder. Osteoporosis was not demonstrated in 20 cases (35.7 per cent). It was present to some extent in 23 cases (41.1 per cent) and was found to be generalized in only 13 cases (23.2 per cent).

Abnormal calcareous deposits or metastatic calcifications were considered under three categories: physiologic, vascular, pathologic types. The physiologic type includes those deposits which are formed in the acid-excreting tissues such as the stomach, kidneys, and lungs. No roentgenologic evidence of such deposition was evident in any of the patients of this series.

The vascular type of calcification was demonstrated in only 18 of the 56 patients, and of these 15 were more than fifty years of age, 2 were forty-eight and forty-four years of age, respectively, and 1 was a woman twenty-six years of age. Although it is thought that vitamin D undoubtedly may enhance this process, the relatively low incidence in the series and the age distribution of those patients having the vascular type of calcification suggest that the presence of this type of calcification itself is not a reliable diagnostic criterion of vitamin D intoxication.

The term "pathologic calcification" refers to calcification of the periarticular tissues, bursal sacs, and rheumatoid nodules, which has been described previously as occurring in some patients who have vitamin D intoxication. Such calcareous deposits were demonstrated roentgenographically in 8 of the 56 patients with vitamin D intoxication. Four conditions coexisted in 7 of these 8 cases. The concentration of phosphorus in the serum was not recorded in the eighth. They did not coexist in any of the other cases of this series. These conditions are: (1) a history of the prolonged and excessive ingestion of large amounts of potent vitamin D preparations; (2) clinical and laboratory evidence of renal insufficiency; (3) concentrations of serum phosphorus exceeding normal (not recorded in 1 of the 8 cases); (4) a destructive arthritic process of unknown etiology, such as rheumatoid arthritis or gouty arthritis. In all except 2 of a series of 9 cases from the literature in which this form of metastatic calcification was demonstrated by roentgenologic and pathologic methods, these four conditions also are known to have been present. In the 2 exceptions the concentration of serum phosphorus at the time of the first admission was not stated.

These deposits of calcareous material in the cases studied have a characteristic putty-like appearance and are essentially as previously described by other authors. They occur in the periarticular regions, presumably within the spaces lined by synovial tissue, within bursal sacs near various bony prominences, and in rheumatoid nodules. Those deposits that form in conjunction with gouty tophi often appear granular or gritty. Because these calcareous deposits are not evident in the periarticular tissues of all the affected joints and bursae, and because they apparently occur only in persons who have rheumatoid arthritis or gout, it is suggested that these diseases may alter the metabolic processes of the local synovial or bursal tissues in some similar manner and in the presence of an abnormally high concentration of phosphorus in serum (probably related to renal insufficiency) provide conditions suitable for the precipitation of salts containing calcium and phosphorus. When recognized, therefore, metastatic calcification of this character not only indicates vitamin D intoxication, but is probably also indicative of rheumatoid or gouty arthritis and renal insufficiency with retention of phosphorus.

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SUMARIO

Las Manifestaciones Roentgenológicas de la Intoxicación por Vitamina D

Este repaso de los protocolos clínicos y las radiografías de 56 enfermos que padecían de intoxicación por vitamina D fué emprendido para determinar la relativa importancia de la presencia de osteoporosis y depósitos anormales de sales calcíferas, observables roentgenológicamente, en el diagnóstico de dicho trastorno. No se descubrió osteoporosis en 20 casos (35.7 por ciento). Estaba presente en cierto grado en 23 casos (41.1 por ciento), y en forma generalizada sólo en 13 (23.2 por ciento).

Los depósitos calcáreos anormales o calcificaciones metastáticas fueron divididos en tres categorías formas: fisiológicas, vasculares y patológicas. Las fisiológicas comprenden los depósitos formados en los tejidos excretores de ácidos, como el estómago, los riñones y los pulmones. En ninguno de los enfermos de esta serie había signos radiológicos de tales depósitos.

La forma vascular de calcificación no fué descubierta más que en 18 de los 56 enfermos. Por sí sola, esa forma de calcificación no se considera como pauta diagnóstica fidedigna de intoxicación por vitamina D.

El término de "calcificación patológica" reza con la calcificación de los tejidos periarticulares, bolsas y nódulos reumatoideos, que ha sido descrita anteriormente en algunos sujetos que padecían de intoxicación por vitamina D. Esos depósitos calcáreos fueron observados radiográficamente en 8 de los 56 sujetos estudiados. En 7 de los 8, coexistían cuatro factores, que no coexistían en ninguno de los demás casos de la serie. Esos factores fueron: (1) historia de prolongada y excesiva ingestión de grandes cantidades de preparaciones potentes de vitamina D; (2) datos clínicos y de laboratorio de insuficiencia renal; (3) concentraciones sobrenormales de fósforo sérico (inobservadas en 1 de los 8 casos); proceso artrítico destructivo de etiología desconocida, tal como artritis reumatoidea o artritis gotosa.

Por no ser visibles esos depósitos calcáreos en los tejidos periarticulares de todas las articulaciones y bolsas afectadas y por ocurrir aparentemente sólo en personas que tienen artritis reumatoidea o gota, sugiérese que estas dolencias acaso alteren los procesos metabólicos de los tejidos sinoviales o bursales locales en forma algo similar y en presencia de una concentración anormalmente alta de fósforo en el suero (probablemente relacionada con insuficiencia renal) y creen condiciones apropiadas para la precipitación de sales que continen calcio y fósforo. Una vez reconocida, la calcificación metastática de ese género indica, por lo tanto, no sólo intoxicación por vitamina D, sino probablemente también artritis reumatoidea o gotosa e insuficiencia renal con retención de fósforo.

DISCUSSION

John D. Camp, M.D. (Los Angeles, Calif.): I think that Dr. Holman's approach to this subject is very much worth while because, instead of analyzing a group of patients who had x-ray changes and describing them as evidence of hypervitaminosis D, he has approached it the other way and determined the incidence and character of x-ray changes in the presence of clinical vitamin D intoxication.

What causes calcium to be deposited in the tissues? Dr. Holman has suggested a shift in the pH values of the tissues as a possible cause. Degeneration in the brain or other organs of the body may be followed by calcification, but other conditions are certainly necessary as well. Courville has shown that in the brain varying degrees of anoxemia occur before calcification. Why calcium deposits form in one tissue and not in others is still not understood. Why does calcification occur with bursitis or peritendinitis in one person and not in another? Why is it accompanied by pain in some instances and not in others? The whole thing emphasizes the complex nature of the calcium balance of the body. The roentgenologic changes associated with some metabolic diseases, and especially hyperparathyroidism, illustrate the danger of trying to change mineral metabolism by adding vitamins, etc., before a definite clinical diagnosis has been established.

I think we should be on the lookout for abnormal calcium deposits and warn our colleagues that they may represent a physiologic mineral imbalance which can be serious although the deposits seem to be focal at the time. Certainly in such situations large amounts of minerals and vitamin D should not be added to the diet until the status of the mineral metabolism of that particular patient is understood.

Roentgen Diagnosis of Intra-Abdominal Hernia

An Evaluation of the Roentgen Findings[1]

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San Francisco, Calif.

INTERNAL HERNIAS, *i.e.*, hernias confined within the abdominal cavity, were first described by Hensing (2) in 1742. Later, Treitz established them as a clinical entity (1857). In 1899, Moynihan (5) listed nine fossae in the duodenojejunal region as possible sites for hernia.

The incidence of internal hernia is not known, though it does occur more commonly than is generally believed. Watson (7) found 3 examples in 1,600 autopsies, and Mitchell (4) encountered one aperture in the mesentery, a potential hernia, in 400 autopsies. Presumably many go undetected.

The possibility of radiologic diagnosis of internal hernia has been neglected by many roentgenologists when making routine gastrointestinal examinations. Clinicians, also, have been remiss in recognizing the associated clinical syndrome and have not referred cases to the roentgenologist for small bowel studies, with this condition in mind. As a result, many internal hernias are overlooked. There are numerous positive roentgen signs of hernia and similar conditions which, when searched for and recognized, will lead to the diagnosis with a reasonable degree of accuracy.

Steinke (6) outlined a simple classification of internal hernias, dividing them into retroperitoneal and anteperitoneal groups. Paraduodenal, paracecal, and intrasigmoid hernias and herniation through the foramen of Winslow are placed in the retroperitoneal group. Herniations through openings in the mesentery and omentum, and into the broad ligament, are placed in the anteperitoneal group. Seldom can the various types of hernia be differentiated roentgenologically. The one reasonably accurate sign is seen in the right paraduodenal hernias, in which the duodenum extends directly to the right from the bulb and the jejunum is displaced to the right and posteriorly.

SYMPTOMATOLOGY

The symptoms are not specific, but in most cases are sufficiently characteristic to suggest the diagnosis. The usual history is of repeated attacks of epigastric discomfort or pain, accompanied by a feeling of distention, variable in periodicity and severity. Commonly, the patient has found that the discomfort may be altered or relieved by change in position, and that it is increased following a large meal but is not affected by the type of food. Nausea is not a constant symptom and usually occurs only in severe attacks. Vomiting is infrequent and in some cases is absent altogether. Appendicitis and duodenal ulcer have been suspected by the attending physician in some instances. One outstanding feature is the absence of clinical signs or laboratory data indicative of inflammatory disease. Usually the patient becomes symptom-free between attacks; rarely are the symptoms unremitting. Duration of symptoms in 40 cases of hernia and torsion studied by the writer has varied from three weeks to forty-one years.

This symptom complex, as well as radiologic findings identical with those of hernia, may be produced either by torsion of the small bowel around congenital bands or by peritoneal adhesions.

RADIOLOGIC EVIDENCE

In order of importance, the radiologic evidences of internal hernia or torsion are: (*a*) displacement or disturbance of small bowel arrangement, (*b*) sacculation or

[1] Presented at the Thirty-seventh Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1951.

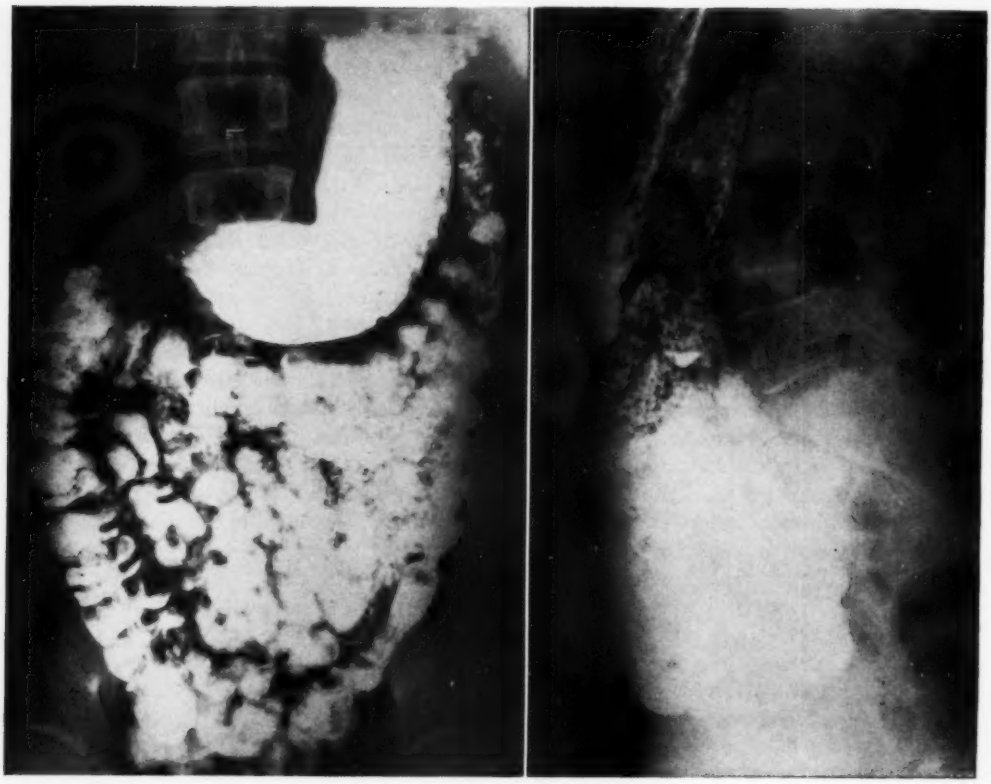

Fig. 1. Normal appearance. When viewed in the erect anteroposterior and lateral positions the small intestine is bounded laterally by the colon; the jejunum is mostly in the left and the ileum in the right side of the abdomen. In the lateral view the small bowel follows the abdominal wall anteriorly and the anterior surface of the spine posteriorly. An occasional loop, normal in caliber, may extend beyond this surface.

clumping, usually found together, (*c*) segmental dilatation, (*d*) stasis, (*e*) reversed peristalsis, and (*f*) fixation. These findings may be limited to an extremely small segment of bowel, a few centimeters in length, or may involve the greater part of the small intestine.

Displacement or Disturbance of Small Bowel Arrangement: Though displacement or disturbance of the small bowel arrangement may be produced by other conditions, the diagnosis of internal hernia is seldom, if ever, justified without this finding. Normally (Fig. 1) the small intestine fills the lower half of the abdomen, extending laterally into each flank, where it is bounded by the colon, and downward into the true pelvis. The jejunum occupies chiefly the left side of the abdomen and the ileum the right. Dilated loops of either extending beyond the mid-line are strong presumptive evidence of the presence of hernia, torsion, or adhesions (Figs. 2–7). This sign is of no value when noted in the prone position, as in this position a transmigration of some part of the small intestine practically always occurs. Anteriorly the small intestine rests against the abdominal wall, and posteriorly, in the erect position, follows the anterior surface of the spine and upper half of the sacrum. Usually the duodenum, and occasionally small loops of jejunum or ileum, may extend posteriorly beyond this surface. The most reliable radiologic sign of hernia is extension of dilated segments of small bowel posteriorly, beyond this surface, seen in the erect lateral view (Figs. 2–7).

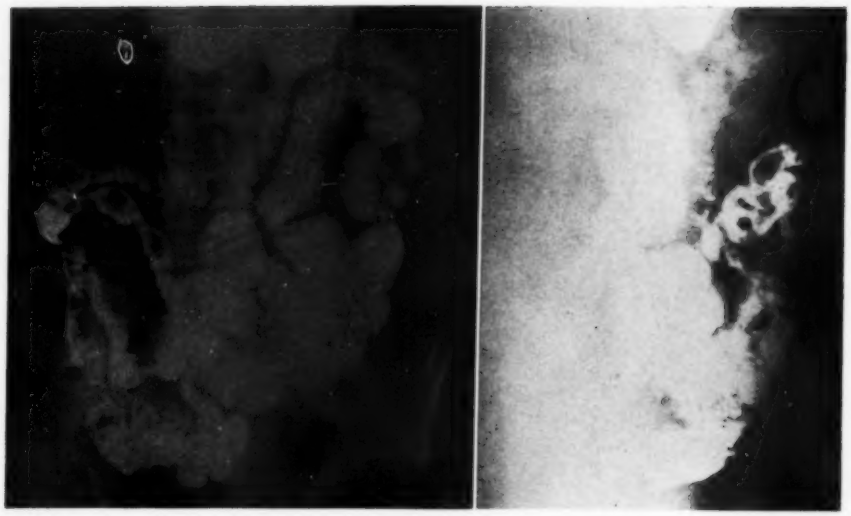

Fig. 2. Left paraduodenal hernia. There are coils of dilated jejunum in the left abdomen in an abnormal pattern, displaced posteriorly beyond the anterior surface of the spine. The ileum on the right is normal in caliber. Dilatation is best determined by comparison with adjacent loops of bowel.

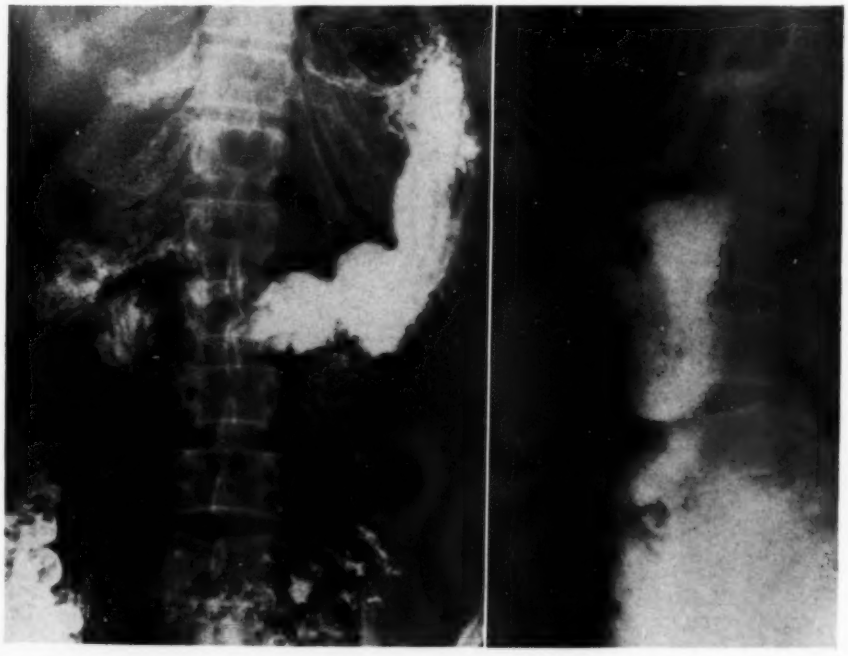

Fig. 3. Right paraduodenal hernia: erect anteroposterior and lateral views. The duodenum passes to the right from the cap. Coils of jejunum are displaced to the right and posteriorly beyond the spine and are moderately dilated. The hernia was reduced inadvertently during exploration.

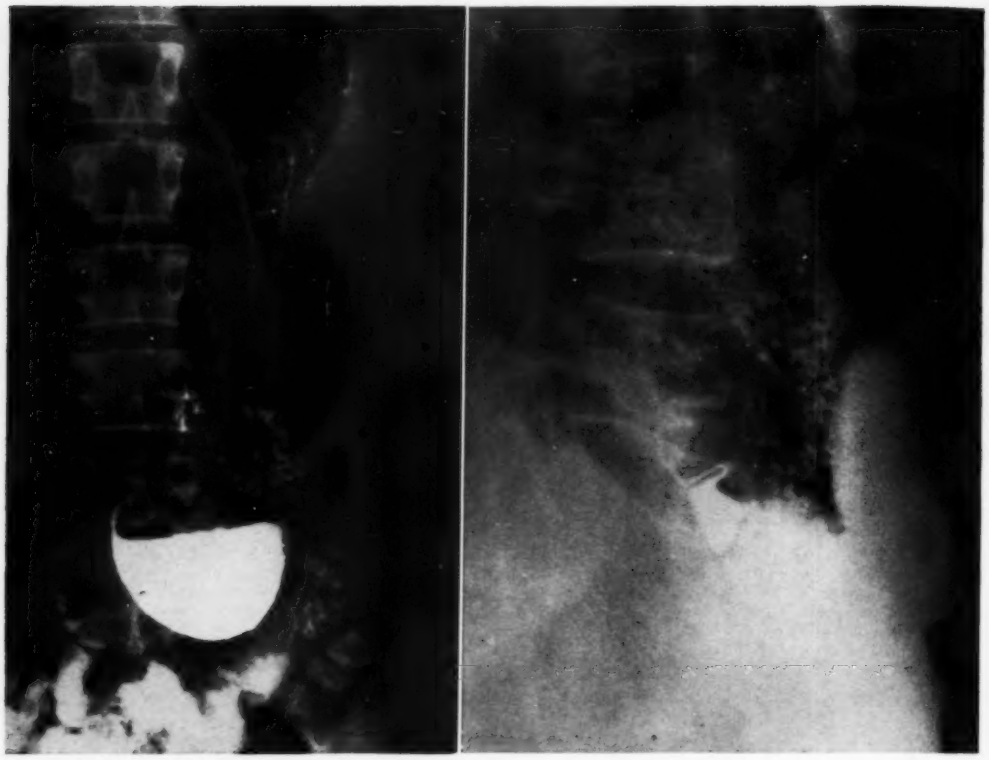

Fig. 4. Intraperitoneal hernia: hernial sac formed by redundant peritoneum passing to the right between the superior mesenteric artery and the aorta near the apex of the mesentery. The sac admitted three fingers readily. The upper jejunum passed into this sac and extended to the right and posteriorly.

In the decubitus position this sign is of no value and should be disregarded (8). Anterior displacement (Fig. 7) away from the surface of the spine, while of significance, is a less dependable finding and may also occur in the presence of tumor (Fig. 8) and adiposity.

Sacculation or Clumping: Loops of small bowel may be closely crowded together as if in an invisible sac (1). They cannot be separated and may be moved *in toto* by pressure or change in position. This is strongly presumptive, but not pathognomonic evidence of hernia and does not occur in all cases. A similar or identical appearance may be produced by torsion of the small intestine around a congenital band or "bunching" by peritoneal adhesions. Only a half of the cases in the writer's series have shown this appearance.

Segmental Dilatation: Segmental dilatation is present only when partial or complete obstruction exists. Dilatation of the duodenum occurred in 4 of 10 cases of hernia and torsion, but was present in all of a group of cases of congenital transduodenal band. When encountered, unless it can be relieved by placing the patient in the horizontal or knee chest position to eliminate the possibility of mesentery artery occlusion or retroperitoneal tumor, it is good evidence of the presence of one of the former conditions, and warrants further small bowel study.

In the small intestine distal to the duodenum, local dilatation when accompanied by displacement usually indicates hernia or torsion. Local dilatation is best determined by comparison with adjacent loops of bowel. No standard of measurement

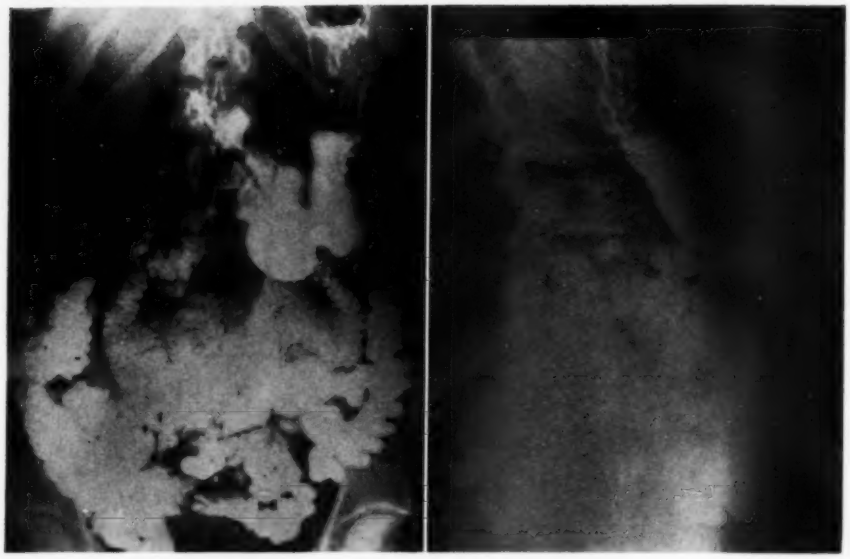

Fig. 5. Transmesenteric hernia. Dilated jejunum is "clumped" in the mid abdomen, extends posteriorly beyond the anterior surface of the spine, and appears to be enclosed within an invisibie sac. The opening in the mesentery was near the ligament of Treitz. The hernia was partially reduced during surgical exploration, before the rent in the mesentery could be located. Surgeons should be aware of the possibility of spontaneous or manual reduction when exploring an abdomen in which hernia is suspected.

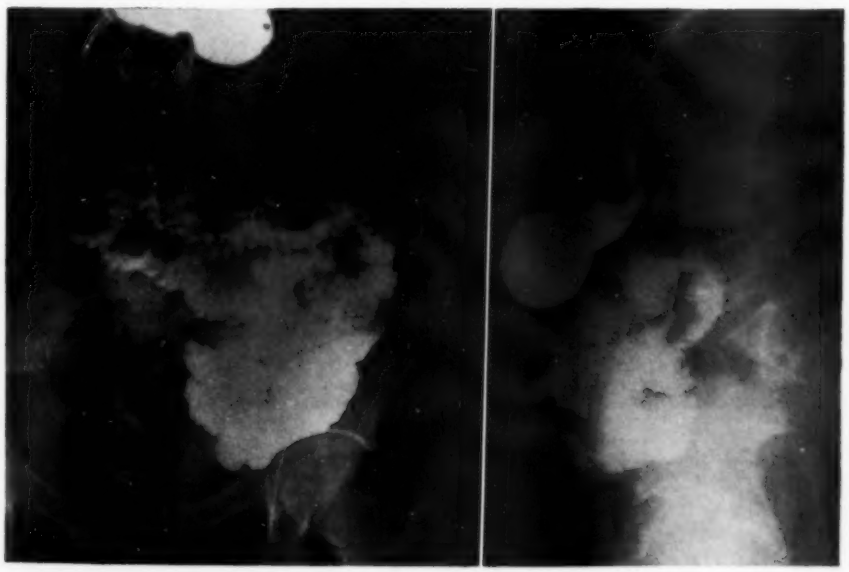

Fig. 6. Torsion of small bowel around postoperative adhesion of the lower part of the greater omentum to the anterior abdominal wall. Dilated loops of jejunum are coiled in the iliac fossa, producing the appearance of sacculation.

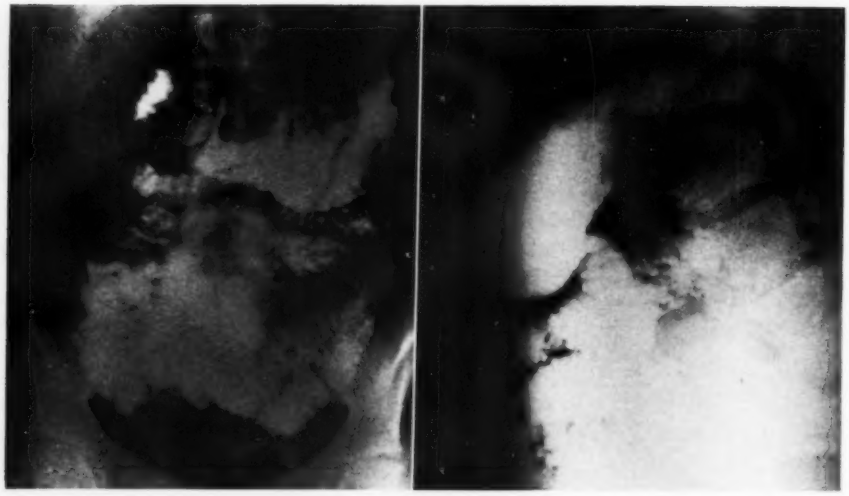

Fig. 7. Torsion of small bowel around a congenital band extending from the mid ascending colon to the mesentery of the terminal ileum. Dilated coils of jejunum are displaced far to the right and anteriorly, away from the spine. Sacculation is simulated.

Fig. 8. Retroperitoneal tumor, metastatic from gastric carcinoma, producing partial duodenal obstruction by pressure on the retroperitoneal portion. This was not relieved when the patient was in a knee-chest position. The erect lateral view shows the small bowel displaced anteriorly away from the spine.

can be applied, since other conditions can increase the diameter of normal small intestine.

Stasis: Stasis is always present to some degree with segmental dilatation and is of equal diagnostic importance.

Antiperistalsis: Antiperistalsis occurs normally in the small intestine and is not

important except when repeated in a given segment and accompanied by stasis and dilatation. It is a usual finding in duodenal obstruction from any cause, but is relieved in the horizontal or knee chest position when it is the result of mesenteric artery occlusion. It may not be affected by position when due to congenital bands, adhesions or hernia.

Fixation: Loss of mobility of a part of the small bowel is not necessarily present. Generally it indicates firm adhesions rather than hernia. It is best observed by change in position during fluoroscopy.

DIFFERENTIAL DIAGNOSIS

In addition to torsion and tumors, previously discussed, congenital non-rotation, masses of small bowel matted together by adhesions, and gravitation of loops of bowel into a renal fossa following nephrectomy may produce confusing findings. A similar appearance might be produced by a short mesentery preventing descent of the small bowel into the pelvis, but without posterior displacement or dilatation and stasis. This has not occurred in the author's experience. Studies with the patient in the erect position should eliminate the possibility of this error in diagnosis. Congenital non-rotation of the small bowel might give rise to confusion, but should be easily ruled out if the position of the colon is determined.

METHOD OF EXAMINATION

As stated, examination for hernia or similar intestinal conditions is not complete unless a detailed small bowel study is done. The patient should always be examined in the lateral erect position, as displacement anteriorly or posteriorly can be determined only in this manner. To repeat, observations in a lateral decubitus position are unreliable and are frequently misleading. The position in which the greatest information may be obtained in anteroposterior projection varies in each case. The findings may be more evident in the erect, supine, Trendelenburg or knee chest position, when low involved loops in the pelvis may be brought into view by gravitation.

TREATMENT

Except for attempted palliation with antispasmodics or low-residue diet, treatment is surgical. The presence of hernia is not a positive indication for surgery *per se*. The symptoms may not be sufficiently severe that the patient is willing to or should undergo an operation for relief. The danger of development of an acute obstruction, while always present, is not great.

McIver (3) reported only 3 internal hernias (0.9 per cent) in a series of 335 cases of acute intestinal obstruction. So, while this is a small hazard, it must be considered in determining the necessity of surgical intervention.

Before undertaking exploration, the surgeon must be aware of the possibility of spontaneous reduction of a hernia or torsion prior to the operation, during the induction of anesthesia or in the course of exploration. In the writer's own experience a hernia through the foramen of Winslow had undergone reduction a short time prior to surgery; at operation, a transmesenteric hernia was partially reduced before the surgeon was able to locate the rent in the mesentery after he found creases on parallel loops of bowel, the site of pressure at the point at which the bowel passed through the mesentery (Fig. 5). In another instance, the surgeon mobilized the duodenum after having explored the entire small bowel and found a large right paraduodenal fossa, into which he could insert his fist (Fig. 3). In numerous cases, the small bowel has been found in normal position at operation, but complete recovery followed severance of congenital bands (Fig. 2). The duodenojejunal region is a common site of these bands, and should be explored when the diagnosis of hernia or adhesions has been made, or is suspected, and no other possible sites of hernia or adhesions are found.

SUMMARY

Internal hernias and torsion of loops of small intestine about congenital bands or adhesions, which may produce a similar clinical and radiological picture, can be diagnosed but not always differentiated by roentgen examination. The primary radiologic sign of these conditions is displacement or disturbance of small bowel arrangement. Secondary findings are segmental dilatation, stasis, antiperistalsis, and fixation. Sacculation or clumping, when found, is important, but does not always occur, and when present does not offer a means of differentiation between hernia and torsion.

Studies of the small bowel are necessary to demonstrate these conditions and must be made with the patient in horizontal and erect positions. Lateral erect studies are the most accurate and informative of all, and should be done in all cases in which hernia or torsion is suspected.

Repeated studies may be necessary and are best made during an attack, as a hernia or torsion may be completely reduced during a remission.

When the diagnosis has been made, the surgeon must be aware of the possibility of spontaneous reduction of the hernia or torsion before or at the time of operation and make a careful search for abnormal fossae, mesenteric defects, or adhesive bands, if herniation or torsion is not found.

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SUMARIO

Diagnóstico Roentgenológico de la Hernia Intraabdominal. Justipreciación de los Hallazgos Roentgenológicos

Con el examen roentgenológico cabe diagnosticar, pero no siempre diferenciar, las hernias internas y la torsión de asas del intestino delgado alrededor de bandas o adherencias congénitas que pueden producir ambas un cuadro clínico y roentgenológico semejante. El signo radiológico primario de dichos estados es desplazamiento o trastorno de la disposición del intestino delgado. Los hallazgos secundarios comprenden dilatación segmentaria, éstasis, antiperistaltismo y fijación. La saculación o apiñamiento, cuando se descubre, reviste importancia, pero no ocurre siempre, y cuando existe, no ofrece medio de diferenciación entre hernia y torsión.

Para descubrir una hernia intraabdominal, se necesitan estudios del intestino delgado y hay que realizarlos con el enfermo en posición tanto horizontal como erecta. Los estudios en posición erecta lateral son los más exactos e informativos de todos y deben llevarse a cabo en todo caso en que se sospeche la existencia de hernia o torsión.

Quizás sean necesarios estudios repetidos y es mejor verificarlos durante un acceso, pues una hernia o torsión puede reducirse del todo durante una remisión.

Ya hecho el diagnóstico, el cirujano debe estar al tanto de la posibilidad de una reducción espontánea de la hernia o torsión antes de la operación o en el momento de ésta y emprender una exploración cuidadosa en busca de fosas anómalas, deformaciones mesentéricas o adherencias, si no descubre ni hernia ni torsión.

DISCUSSION

Roger A. Harvey, M.D. (Chicago, Ill.): Dr. Williams' presentation clearly indicates that in internal hernia we are not facing a rare or unusual problem. As he has brought out, the more often we suspect this condition the more often we will make the correct diagnosis.

Our own experience with intra-abdominal hernia is probably typical, in that the symptoms are not severe enough to create much urgency on the part of the internist or surgeon in getting a work-up on these patients. The manner of approach is partly our own fault, I think. As a rule, the study is started with a barium enema rather than barium by mouth, for the vague abdominal signs. The findings are usually normal. A pyelogram follows, also usually normal, as are the examination of the upper digestive tract and the subsequent small bowel study. By the time the upper gastrointestinal examination is performed the patient feels fine—the symptoms left yesterday, or even a week ago—and the radiologist wonders why he is making the examination. But when he lines up all the findings—in the colon, on the pyelogram, and on the upper gastrointestinal films—he is impressed by the fact that there was an abnormal collection of gas in the small bowel area and on the colon films, a lesser or altered gas shadow on the pyelogram, and none on the upper intestinal tract films.

What we have come to do with these patients is to tell them the next time they feel this group of symptoms coming on to report directly for an upper gastrointestinal examination, so that we have a better chance of making the diagnosis.

I am sure that a needless number of people are being termed abdominal neurotics because of lack of proper procedures in diagnosing their difficulties.

Roentgen Therapy of Peritendinitis Calcarea of the Shoulder

A Study of 220 Cases with Late Results[1]

EMIL A. KRATZMAN, M.D.[2], and ROBERT S. FRANKEL, M.D.[3]

THE PATHOLOGY, roentgen appearance, and clinical aspects of peritendinitis calcarea are familiar to all, having been described in the literature at frequent intervals. Almost as well known are the various procedures for its treatment, though opinion is far from uniform as to the preferred method in a selected case. The fact that the acute process is self-limiting and will subside spontaneously is hardly of comfort to the sufferer.

In recent years irradiation has become a more popular form of therapy in this condition, especially in its acute form. This procedure holds a great appeal for patient and doctor alike: it is painless, involving no dreaded needles, excessive handling, or motion of the painful limb; it satisfies the patient's desire for active intervention; it is followed by relief, often dramatic in its promptness.

In considering any form of treatment of this condition, immediate relief is the prime consideration, but the ultimate course is only slightly secondary. If the effect of other methods were only transient, it would be best to operate whenever there is x-ray evidence of calcium and thus forestall recurrence.

We have reviewed 220 cases receiving x-ray therapy not only to compare our method and results with those of others but also to determine the end-results. In going through our files, we discovered a number of instances of the peritendinitis calcarea syndrome in other locations than the shoulder: in the region of the greater trochanter, 4 cases; wrist (carpals), 2 cases; hand (metacarpal), 1 case; elbow, 2 cases. Involvement of such areas has been reported (1, 7) but is not included in most papers on the subject and is of much less frequent occurrence, perhaps, as has been pointed out, because of the mechanical disadvantage incident to the position of the arm in man (8). We believe that these cases occur more often than is generally believed, in many instances being passed off as "sprained wrist," arthritis of the hip, etc.

X-ray therapy in acute tendinitis is well regarded in the literature, but most series have been small and follow-up statistics are few. Why the condition is relieved by irradiation is unknown, but the general feeling seems to be that the hyperemia induced decreases inflammation and swelling of the tendon, as it often does in other inflammatory conditions. Caldwell and Unkauf (3) suggest that this may be why relief is gradual rather than sudden, but actually relief is often strikingly rapid and it may occur gradually without treatment. Other writers postulate the disappearance of pain on the basis of the non-specific analgesic effect of x-rays (11), though this too may actually be the result of hyperemia.

In our series of 220 cases, covering the period from January 1948 through June 1950, clinical classification was determined by the duration of the symptoms: acute cases, one week or less; subacute cases, one to four weeks; chronic cases, more than four weeks. This time relationship corresponds to that of other writers and thus affords a basis for comparison of results. The 220 cases are also divided into three groups on the basis of follow-up: (1) those with follow-up results; (2) those

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TABLE I: CLINICAL AND STUDY GROUPING

	Acute	Subacute	Chronic	Total
With follow-up	79	16	62	157
Lost to follow-up	19	3	16	38
Without follow-up	9	4	12	25
Total	107	23	90	220

lost to follow-up; (3) those with no follow-up study (Table I). No case was considered as having a follow-up study unless a period of three months had elapsed since the completion of the radiation therapy. The method of obtaining late results was by personal letter and questionnaire. Of 195 patients so contacted, 157 (80.5 per cent) returned replies. Numerous patients enclosed encouraging notes with their replies, and several patients stated that the treatment and results were most excellent.

Of our series of 220 patients, 119 were males and 101 were females, with the following age distribution: 1 patient (female) in the 15 to 20-year age group; 9 (4 males and 5 females) in the 21 to 30-year group; 29 (15 males and 14 females) in the 31 to 40-year group; 90 (45 males and 45 females) in the 41 to 50-year group; 60 (38 males and 22 females) in the 51 to 60-year group; 26 (14 males and 12 females) in the 61 to 70-year group; 5 (3 males and 2 females) over 70 years of age. The findings of practically equal sex distribution and the preponderance of cases in the fourth through the sixth decade agree with other presentations. (4, 7, 12, 13)

The right shoulder was involved 123 times and the left 114. In 17 cases involvement was bilateral. In only 150 of the 220 cases were roentgenograms of the shoulder obtained, and of these 131 showed calcifications. During the review of our cases we attempted to correlate the type of calcification (amorphous, osseous, or mixed) with the results and the rapidity of response. No relationship was discovered. This was previously noted by Baird (2), Steen and McCullough (12), and Young (13).

The chief complaint in 209 patients was pain localized to the shoulder area, which increased on any sudden or violent motion. Limitation of motion was present in 79 patients. It was associated with localized pain in several instances but in many of the chronic cases was the only presenting complaint, with little or no discomfort. Other forms of therapy had been attempted in 54 cases before the patient was referred to the x-ray department for treatment: physiotherapy in 28; local novocaine injection in 15; aspiration in 6; osteopathy in 4; local iron salicylate injection in 1.

The irradiation factors for all cases were: 200 kv.p.; 0.5 mm. copper with 1.0 mm. aluminum filtration; 50 cm. skin-target distance; 15 ma. Treatment was given through a 10 × 10-cm. portal over the anterolateral aspect of the shoulder, 150 r, measured in air, being administered every other day for a total dose of 450–600 r.

The results of treatment are subdivided into twelve categories, most of which are self-explanatory. "Improved" indicates improvement of all symptoms, with a minimal residual. "Over-all aided" refers to the combination of complete relief and improvement in the other categories. Immediate results are those at the completion of the x-ray therapy. Table II shows the immediate and late results (number of cases and percentages) for the acute, subacute, and chronic cases, and for all combined.

In all clinical classifications the number of immediate cases exhibiting complete relief of symptoms is less than that of late cases of the same category, while the figures for "over-all aided" are relatively constant. This we believe is due to several factors: (*a*) our requirements for this category, namely complete disappearance of all symptoms; (*b*) the known fact that improvement with irradiation is often gradual; (*c*) the short time interval required for the completion of therapy (maximum eight days).

The 1 case in the acute group showing no improvement in respect to pain was complicated by an acromioclavicular separation. In the 1 case in the subacute

TABLE II: IMMEDIATE AND LATE RESULTS IN AUTHORS' SERIES.

	Complete Relief	Improved	Over-all Aided	No Response	Pain Gone	Less Pain	Over-all Aided	No Change in Pain	Motion Normal	Motion Improved	Over-all Aided	No Change in Motion
Acute Cases												
Immediate results	56	49	105	2	60	23	83	1*	48	7	55	1
107 cases	52.33%	45.79%	98.12%	1.77%	71.42%	27.38%	98.80%	1.19%	85.71%	12.50%	98.21%	1.78%
Late results	72	6	78	1*	66	4	70	1*	65	3	68	0
79 cases	91.13%	7.59%	98.72%	1.26%	92.95%	5.63%	98.59%	1.40%	95.58%	4.41%	100%	0
Subacute Cases												
Immediate results	8	14	22	1†	12	10	22	0	11	6	17	1†
23 cases	34.78%	60.86%	95.65%	4.34%	54.54%	45.45%	100%	0	61.11%	33.33%	94.44%	5.55%
Late results	11	4	15	1†	12	3	15	0	14	0	14	1†
16 cases	68.75%	25.00%	93.75%	6.25%	80.00%	20.00%	100%	0	93.33%	0	93.33%	6.66%
Chronic Cases												
Immediate results	7	61	68	22	14	51	65	15	16	33	49	3
90 cases	7.77%	67.77%	75.54%	24.44%	17.50%	63.75%	81.25%	18.75%	30.76%	63.46%	94.22%	5.76%
Late results	32	18	50	12	35	22	57	1	41	11	52	5
62 cases	51.61%	29.03%	80.64%	19.35%	60.34%	37.93%	98.27%	1.72%	71.92%	19.29%	91.21%	8.77%
All Cases												
Immediate results	71	125	196	24	86	85	171	15	75	47	122	4
220 cases	32.27%	56.81%	89.08%	10.90%	46.23%	45.69%	91.92%	8.06%	59.52%	37.30%	96.82%	3.17%
Late results	115	28	143	14	113	30	143	1	120	15	135	5
157 cases	73.24%	17.83%	91.08%	8.91%	79.47%	20.83%	99.30%	0.69%	85.71%	10.71%	96.42%	3.57%

* Acromioclavicular separation.
† Large calcific mass, surgically removed.

TABLE III: RESULTS OF ROENTGEN THERAPY AS REPORTED IN THE LITERATURE

Author	Cases	Favorable Results				Complete Relief or Improved	No Relief
		Acute	Subacute	Chronic	Remarks		
Baird (2)	18	9 cases	5 cases	4 cases	16 cases completely cured		
Chapman (4)	54	94%	77%	33%	Chronic cases are those over one year		
Gelber (5)	15					86%	14%
Harris (6)	40	Best results		Improved	Author regards the chronic case as an orthopedic problem		
Hodges and Boyer (7)	200	89%	75%	Unable to evaluate	Chronic cases on whole disappointing. Surgery recommended after trial of irradiation		
Klein (9)	100	All excellent	26 days disability	36 days disability	Acute cases respond best to x-ray therapy		
Pohle and Morton (11)	78				Additional benefit with further treatment was not striking	84%	16%
Steen and McCullough (12)	300				Immediate results	83.6%	12.6%
					Late (follow-up) results	89.0%	11.0%
Young (13)	87	87%	82%	33%	These are follow-up results		
Kratzman and Frankel	220	98.12%	95.65%	75.54%	Immediate results		
	157	98.72%	93.75%	80.64%	Late (follow-up) results		

group that did not respond there was an extremely large osseous calcific deposit (3 × 1.6 cm.). Surgical removal of this deposit was later performed with excellent results.

The distribution of cases by months from completion of therapy is as follows: three months, 6 cases; four to six months, 5 cases; seven to nine months, 13 cases; ten to twelve months, 19 cases; thirteen to fifteen months, 10 cases; sixteen to eighteen months, 12 cases; nineteen to twenty-one months, 17 cases; twenty-two to twenty-four months, 17 cases; twenty-five to twenty-seven months, 14 cases; twenty-eight to thirty months, 16 cases; thirty-one to thirty-three months, 12 cases; thirty-four months, 4 cases; thirty-six months, 1 case; thirty-seven months, 3 cases; forty-two months, 2 cases; forty-three months, 3 cases; forty-nine months, 1 case; fifty-six months, 1 case; one hundred four months, 1 case. The 12 cases ranging from thirty-six to one hundred and four months represent the first involvement of 12 of the 17 patients who had bilateral peritendinitis.

A comparison of our results with those of other series is presented in Table III.

CONCLUSIONS

Based on this series of 220 cases, with late results in 157 cases, the following conclusions as to roentgen therapy of peritendinitis calcarea of the shoulder are evident:

1. Complete relief of symptoms with return to normal motion and absolute freedom from pain is often a gradual process.
2. Immediate responses are usually remarkable and most gratifying.
3. The figure for "over-all aided" is relatively constant in both the immediate and late results, indicating the permanency of the results.

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SUMARIO

La Roentgenoterapia de la Peritendinitis Calcárea del Hombro. Estudio de 220 Casos con los Resultados Tardíos

Doscientos veinte casos de peritendinitis del hombro fueron tratados con los rayos X, con los siguientes factores: 200 kv. p., 15 ma., filtro 0.5 mm. de cobre más 1.0 mm. de aluminio, distancia foco-piel de 50 cm. El tratamiento fué administrado a través de una puerta de 10 × 10 cm. sobre la cara anterolateral del hombro, 150 r (medidos al aire) cada dos días, hasta una dosis total de 450 a 600 r.

Los resultados tardíos, disponibles para 157 casos, revelaron alivio total en 73.24 por ciento, en tanto que mejoraron 17.83 por ciento. Los mejores resultados tardíos correspondieron a los casos agudos: 91.13 por ciento aliviados totalmente y 7.59 por ciento mejorados. Las cifras correspondientes para 16 casos subagudos fueron de 68.75 por ciento y 25 por ciento, y para 62 casos crónicos, 51.61 por ciento y 29.03 por ciento.

El alivio total de los síntomas con retorno de la movilidad normal y desaparición del dolor constituye a menudo un proceso gradual. Las cifras de los "ayudados en alguna forma," es decir, de los aliviados totalmente y los mejorados, es relativamente constante tanto en los resultados immediatos como en los tardíos, indicando la permanencia de los efectos.

Bronchography with Water-Soluble Contrast Medium[1]

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THE GREAT progress in the field of thoracic surgery during recent years has created increased interest in bronchography. Lipiodol, *i.e.*, iodized poppy seed oil, was introduced as a contrast medium by Forestier thirty years ago. Iodized oil, however, is not an ideal contrast medium for bronchographic studies. The oil does not mix with the bronchial secretion; it has a tendency to droplet formation, which may give a false impression of a stop. The oil may be retained in the alveoli for a considerable time, often several months. This circumstance increases the risk of postoperative complications after thoracic surgery, especially the development of atelectasis. The interpretation of follow-up roentgenograms is made difficult by the retained contrast material, and there are reports indicating that the continued presence of oil in the lung may cause delayed pneumonia and oil granuloma (1, 3, 8).

In 1948, Morales and Heiwinkel (5, 6) introduced a water-soluble contrast medium called "Umbradil-Viskös B" for bronchography. It is an aqueous solution containing 50 per cent of Umbradil (diethanolamine salt of 3,5-diiodo-4-pyridone-N-acetic acid) made viscous by the addition of 2.7 per cent of carboxymethylcellulose (CMC), and 0.5 per cent of xylocain. Subsequently similar media have been devised in Switzerland (Joduron B) (2), Germany (Viscous Perabrodil M, 60 per cent), and in the United States, where Diodrast has been utilized in combination with pure methylcellulose (7).

Hellström and Holmgren (4) of Sweden have studied the reaction in the lung in animals after experimental bronchography with viscous Umbradil. From all indications the changes produced by the instillation are of a reversible nature. W. Vischer (9) of Switzerland claims that bronchography with Joduron B may give rise to the same histologic changes as those following the use of Lipiodol.

At the Roentgen Department, Rikshospitalet, Oslo, we have during the last three years performed practically all bronchographies with viscous Umbradil. We have seen no untoward effects from this contrast medium. Our technic includes the following steps:

Fig. 1. Marstranders spatula with rubber catheter inserted.

(*a*) Premedication with barbiturates combined with atropine and codein.

(*b*) Spraying and swabbing of the fauces and larynx with a 2 per cent Tetracain (Pantocain) solution.

(*c*) Instillation of 1 to 2 ml. of a 2 per cent solution of xylocain into the trachea.

(*d*) Introduction of a rubber catheter coated with Tetracain ointment into the trachea and the desired main bronchus under fluoroscopic guidance. A specially designed spatula may be used for introduction of the catheter through the glottis (Fig. 1).

(*e*) Anesthesia of the bronchial tree. A fractionated instillation of xylocain is made through the catheter into the open-

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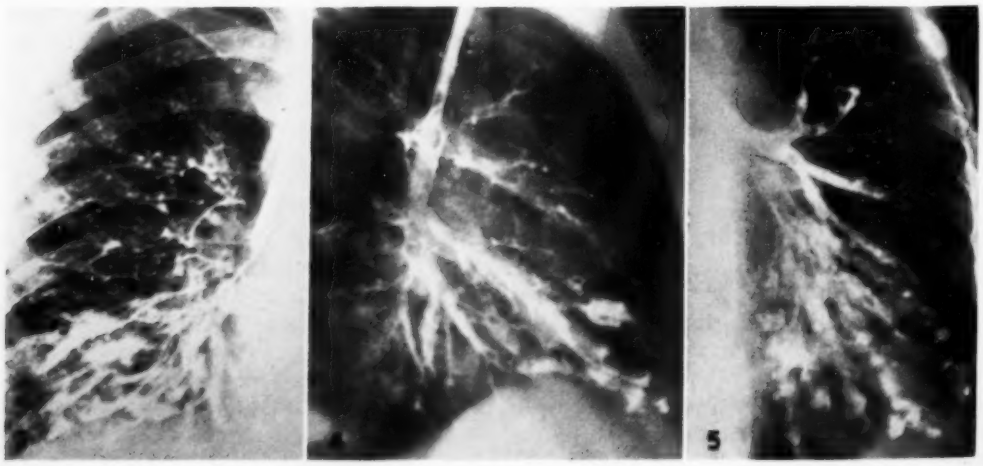
Fig. 2. Normal bronchogram with viscous Umbradil.

ings of the various lobar bronchi. By changing the patient's position, the anesthetic can be distributed in the various lung segments. It is very important that the anesthesia be performed on a fluoroscopic tilting table in order to check the position of the catheter tip by fluoroscopy before each instillation. Use is made of 4 ml. of a 2 per cent solution of xylocain, or 6 to 8 ml. of a 1 per cent solution, for the bronchial anesthesia.

(*f*) Three to four minutes after completion of the anesthesia the contrast medium is injected through the catheter under fluoroscopic guidance. The roentgenograms are taken as spot films on the tilting fluoroscopic table during the different phases of bronchial filling. The exposures must be made in rapid succession because of the rapid absorption of the contrast medium and because of the cough which is apt to develop within a few minutes after the injection. By changing the patient's position during the injection, adequate filling of the various segmental bronchi can be achieved. Care should be taken not to get an overflow of contrast medium into the non-anesthetized bronchi of the other lung. If examination of the other side is desired, this should be postponed a day or so.

In cases where localized lesions are sought, we aim at a selective bronchography, for which purpose the different



Figs. 3–5. Case I. 3. Bronchogram of right side. 4. Same side, lateral view. Marked cylindrical bronchiectasis localized almost entirely in the middle lobe; slight involvement of the cardiac segment. 5. Bronchiectasis of entire left lower lobe and lingular segment of upper lobe.

Figs. 6 and 7. Case II. 6. Abscess in the left lower lobe. 7. Cavity filled with viscous Umbradil *via* localized bronchiectasis.

Fig. 8. Case III. Status after lobectomy of right lower lobe. Contrast filling of residual extrapulmonary cavity (arrow) *via* fistula from amputation stump of lower lobe bronchus. Cylindrical bronchiectasis in atelectatic middle lobe.

kinds of Metras' catheters have been found useful.

The following cases in which viscous Umbradil was used for bronchography illustrate the usefulness of this contrast medium. Figure 2 shows a normal bronchogram.

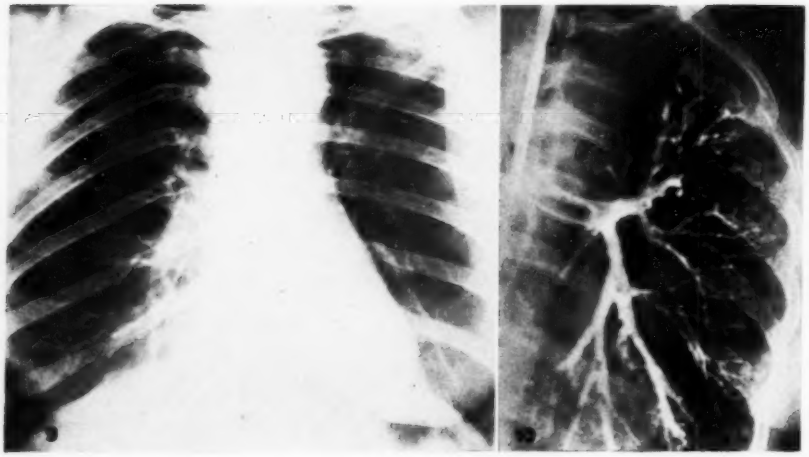
CASE I: J. S., a 14-year-old boy, gave a history of chronic cough and abundant expectoration following tonsillectomy four years previously. Bronchography revealed bronchiectasis on both sides (Figs. 3–5).

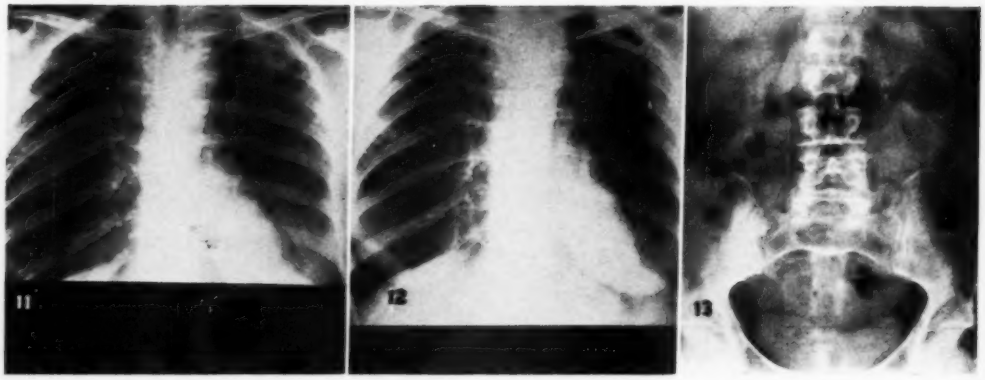
CASE II: K. J., a 31-year-old man, was admitted because of acute pulmonary disease with fever, cough, and expectoration. Bronchiectasis of the left lung had allegedly been demonstrated fifteen years previously in another hospital. Thereafter the patient had been well until six days prior to admission. On admission he was afebrile. X-ray studies showed an abscess basally in the dorsal part of the lower lobe (Fig. 6). Bronchography revealed localized bronchiectasis with communication with the abscess cavity (Fig. 7).

CASE III: A. P., a 56-year-old man, gave a history of repeated bouts of pneumonia since the age of sixteen and cough with occasional blood-tinged expectoration for five years. Lobectomy of the right lower lobe had been performed in another hospital three years previously. Planigrams revealed abscess formation at the base of the right lung dorsally. Bronchography showed an extrapulmonary abscess cavity filled with contrast medium from the amputation stump of the lower lobe bronchus (Fig. 8).

CASE IV: A. R., a 56-year-old woman, gave a history of recurrent colds with cough and occasionally blood-tinged expectoration following pneumonia twelve years previously. She was admitted to the hospital with a question of lung tumor. Plain films and planigrams revealed a round density, limited by an air meniscus, in the left upper lobe (Fig. 9). Bronchography revealed some irregularity of the bronchi in the apicodorsal segment and an irregular cavity partially filled with contrast medium (Fig. 10). Operation (segmental resection) revealed a bronchial cyst containing a semisolid material and communicating with the bronchial tree. A slight haziness of the left lung seen four hours after bronchography (Fig. 11) had, as usual, completely disappeared on a routine follow-up roentgenogram the next day (Fig. 12). A flat film of the abdomen, taken thirty minutes after bronchography (Fig. 13), shows the rapid absorption of the contrast medium by demonstration of the excreted Umbradil in the kidney, pelvis and urinary bladder.

CASE V: K. A., a woman aged 22, was admitted to the surgical department for possible lobectomy because of a tuberculous process of the right lower lobe. Planigrams showed that the process, which consisted of fibrosis and shrinkage, was not limited to the lower lobe. Bronchography (Fig. 14), performed for the purpose of determining the nature and extension of the lesion, revealed bronchiectasis in the lower and middle lobes, both of which were shrunken, and bron-





Figs. 9—13. Case IV. 9. Before bronchography. 10. Bronchogram showing small amount of contrast medium in the cavity in the apicoposterior segment of the left upper lobe. 11. Four hours after bronchography, showing almost complete disappearance of the medium. 12. Twenty hours later; no evidence of medium and no reaction. 13. Flat film of abdomen thirty minutes after bronchography.

chiectasis of the posterior segment of the upper lobe as well.

CASE VI: O. V., a 59-year-old man, gave a history of repeated hemoptyses for six years. Bronchography (Fig. 15) revealed a typical tumor stenosis of the stem bronchus above the ostium of the middle lobe bronchus. Operation revealed an occluding bronchial adenoma.

CASE VII: K. S., a 57-year-old man, gave a history of chronic bronchitis since childhood and occasional fever for one year. A plain roentgenogram (Fig. 16) showed an atelectatic-like density in the left upper lobe. Tumor cells could not be demonstrated in the bronchial secretion. Bronchoscopy revealed mucopurulent secretion in the left upper lobe bronchus with edema of the mucous membrane. Bronchography (Fig. 17) showed obstruction of the upper branch of the lingular bronchus with atelectasis of the dependent part of the lung. Lobectomy was performed and revealed a squamous-cell bronchial carcinoma.

SUMMARY AND CONCLUSIONS

Bronchograms obtained by viscous Umbradil are usually of good quality, and are often superior to those obtained with an oily medium. The water-soluble contrast medium has the advantage that it tends to adhere to the bronchial mucosa better than oil. Also it mixes readily with the bronchial secretions, while the oil will frequently separate into droplets. The greatest advantage is the rapid disappear-

Fig. 14. Case V: Tuberculosis of the right lung. Lateral bronchogram showing bronchiectasis in shrunken lower and middle lobes. Bronchiectasis also in posterior segment of upper lobe.

Fig. 15. Case VI: Complete stenosis of right stem bronchus produced by an occluding bronchial adenoma.

Fig. 16. Case VII: Atelectatic density in right upper lobe. See also Fig. 17.

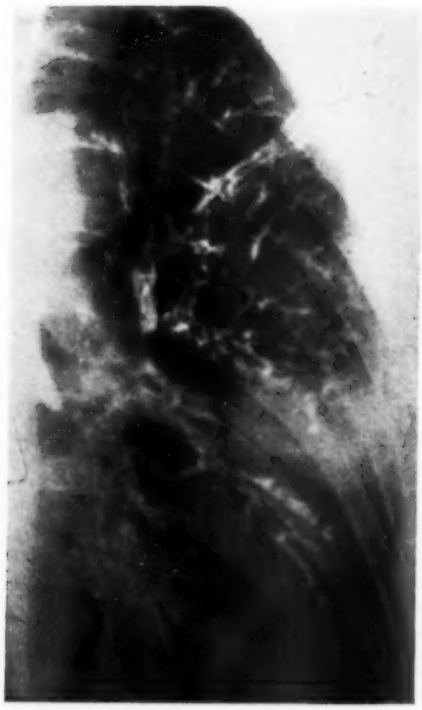


Fig. 17. Case VII: Bronchogram showing obstruction of upper branch of lingular bronchus by squamous-cell carcinoma.

ance of the medium from the lung. Thoracic surgeons have been most satisfied with this method. After oil bronchography operation often has to be delayed until as much oil as possible has been expectorated. Otherwise the surgeon, in order to save time, may have to operate while considerable amounts of oil still remain in one or both lungs. This involves an increased risk of postoperative complications, particularly atelectasis.

The introduction of a water-soluble contrast medium has increased the number of bronchographies performed in our department. The present water-soluble medium, however, is not yet perfect. It has a more immediate local irritating effect than oily media and necessitates a more extensive and tedious anesthesia, making its use more time-consuming. Sufficient anesthesia may be obtained, however, without overdosage of the anesthetic.

We wish to stress the importance of adequate anesthesia, especially that of the bronchial tree, as an essential point for a successful bronchography.

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SUMARIO

La Broncografía con un Medio Hidrosoluble de Contraste

Desde hace tres años han ejecutado la broncografía en el Departamento de Roentgenología del Rikshospitalet, de Oslo, casi exclusivamente con Umbradil viscoso, solución acuosa de Umbradil convertida en viscosa por la adición de carboximetilcelulosa y xilocaína.

Los broncogramas obtenidos con el Umbradil viscoso suelen ser de buena calidad, y a menudo superiores a los obtenidos con un medio oleoso. El medio hidrosoluble de contraste posee la ventaja de que tiende a adherirse mejor que el aceite a la mucosa bronquial. Además, mézclase fácilmente con las secreciones bronquiales, en tanto que el aceite se separa frecuentemente en gotillas. La mayor ventaja de la preparación hidrosoluble consiste en su rápida desaparición del pulmón, permitiendo así la cirugía inmediatamente sin peligro de las complicaciones postoperatorias acarreadas por los residuos de aceite.

Sin embargo, el actual medio hidrosoluble de contraste no es todavía perfecto. Ejerce un efecto irritante local más rápido que los medios oleosos y exige anestesia más extensa y engorrosa, obligando a consumir más tiempo. No obstante, cabe obtener suficiente anestesia sin hiperdosis del anestésico.

Recálcase la importancia de la anestesia adecuada, en particular del árbol bronquial, para el éxito de la broncografía.

DISCUSSION

W. Edward Chamberlain, M.D. (Philadelphia, Penna.): I am sure that I speak for everyone in this audience when I say that Dr. Poppe's paper is of the greatest practical interest to all radiologists. We had heard or read of this work, and some of us had made a cursory trial of the method, with poor or indifferent results. Dr. Poppe's work has convinced me that our failure to get satisfaction from using his method is probably due to our not getting the original material, viscous Umbradil, direct from Scandinavia. (I understand that the material we used came from an entirely different source, not from Scandinavia.) With Dr. Poppe's paper as our guide, we shall certainly renew our trials, with care to use only the original and authentic material which he has found so satisfactory.

I have two questions to ask Dr. Poppe: (1) Does he know what has been done or what is being done toward lessening the irritation which is the chief disadvantage of viscous Umbradil, or toward the production of some less irritating resorbable material? (2) What is known regarding the absorption of the carboxymethylcellulose which is present to the extent of 2.7 per cent and is responsible for the viscosity of the material? Could it be that the radiopaque Umbradil is absorbed promptly but the cellulose compound remains in the lung? And if so, is there not a possibility that some granulomatous reaction may be produced in the lung?

Erik Poppe, M.D. (*closing*): In answer to Dr. Chamberlain's second question, Hellström and Holmgren of Sweden have done experimental bronchography on animals with viscous Umbradil. The Umbradil component is absorbed directly. The carboxymethylcellulose component is probably not absorbed directly but is ingested by the alveolar phagocytes, whereupon it is either split or passes out into the blood. Hellström and Holmgren used toluidin blue to show the carboxymethylcellulose granules in the phagocytes. Histological examination after bronchography on animals showed thickened septa and increased blood content. These findings had disappeared about three weeks after the procedure.

Vischer of Switzerland concludes that Joduron B, which he used for bronchography, can produce the same histologic findings as Lipiodol.

In the University Hospital of Oslo we have not seen any untoward effects of viscous Umbradil during the three years we have used it.

Answering Dr. Chamberlain's first question, I hope that in about a year we may have a new contrast medium which is better than viscous Umbradil.

Congenital Absence of the Pedicle and Superior Facet from a Cervical Vertebra

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CONGENITAL absence of a pedicle and facet from a cervical vertebra has received scant attention in the radiological literature in spite of the fact that it is probably not rare. Hadley (1) described three cases and mentioned that such a finding may cause confusion, especially following an accident. The lesion must be differentiated from absence of a pedicle due to erosion or destruction by a neoplastic process such as a neurofibroma involving the nerve root or a primary lesion of the pedicle itself.

REPORT OF CASE

M. T., a 28-year-old housewife, was well until April 30, 1950, when she swallowed a squab bone, following which she had severe, constant pain below the right sternoclavicular joint. She had a cough but no hemoptysis, hematemesis, or melena. On the next day a roentgen examination of the pharynx and esophagus was done, followed a day later by esophagoscopy. No foreign body was found. After a week the acute pain subsided to a constant, dull, uncomfortable feeling in the region of the right acromioclavicular joint.

The patient's past history was irrelevant except for a fall two years previously, which resulted in a fracture of a lumbar vertebra. She gave no history of injury to the neck. Occasionally, since birth, she had experienced a sensation of numbness in the third and fourth fingers of the right hand. No pertinent objective abnormalities were found on physical examination.

Roentgenographic examination of the pharynx and esophagus on May 11 showed no evidence of a foreign body. An abnormality of the cervical spine was noted, however, and additional films of this region were obtained, including anteroposterior, stereolateral, and stereo-oblique views. These roentgenograms showed the cervical spine to be tilted to the right at the level of the seventh cervical intervertebral disk. The right pedicle of the seventh cervical vertebra was absent, allowing the sixth and seventh cervical intervertebral foramina to communicate, giving the appearance of a single large foramen. The lamina of the seventh vertebra was developed to a greater than normal size on the right side and had articulated with the posterior surface of the lamina of the sixth cervical vertebra. Due to the increase in size of this lamina and the tilt of the spine to the right, the neural arches of the fifth and seventh cervical vertebrae were in close proximity to each other. The superior articular facet and posterior portion of the transverse process on the right of the seventh cervical vertebra were absent. An anterior or costal portion of the transverse process remained (Fig. 1). A vertebral arteriogram obtained on May 15 demonstrated a normal appearing right vertebral artery.

It was felt that the underlying lesion was probably a tumor which had eroded the pedicle of the seventh cervical vertebra and had heretofore caused no symptoms.

The cervical region was explored operatively on May 17. The right sixth cervical lamina was found to have swung forward so that the lower edge of the lamina of the fifth cervical vertebra and the upper edge of the lamina of the seventh cervical vertebra were but 1 to 2 mm. apart laterally. The lower part of the lamina of the fifth cervical vertebra and all of the lamina of the sixth were then removed. With this exposure, it was possible to demonstrate a large space filled with loose tissue, extending from the pedicle of the sixth to that of the first thoracic vertebra. The foramen between the fifth cervical vertebra and the sixth appeared to be normal. No tumor could be found, despite an extensive search of the entire region both within the spinal canal and outside of the foramen. The seventh and eighth cervical nerves came off together. The seventh cervical nerve arose along the edge of the dural sac at a point about midway between the site of emergence of the sixth and eighth cervical nerves. It then left the canal just below the sixth cervical root. The spinal cord seemed undistorted; the vertebral artery could be demonstrated in the lateral reaches of the wound.

Following surgery, the patient had much pain, which radiated into the shoulder and arm and into the right suboccipital region, temple, and retro-orbital area. Myelograms were then obtained to rule out some anomaly not revealed in previous studies. These demonstrated the presence of two nerve roots emerging from the enlarged right sixth intervertebral foramen. No other abnormality was noted. After a prolonged period of exacerbation and remission of the distressing postoperative symptoms,

[1] From the Divisions of Radiology and Neurosurgery and the Subdivision of Otorhinolaryngology, University of California School of Medicine, San Francisco, Calif. Accepted for publication in February 1952.

they finally subsided. Traction and cervical immobilization were apparently of most value in relieving the pain.

DISCUSSION

The absence of a pedicle from the cervical vertebra apparently may be tolerated for a long period of time without symptoms. Hadley's three patients had neck pain which presumably was due to hypertrophic arthritis in one patient, and the result of trauma in the other two. However, pain appears to be the usual presenting symptom. Clinical differentiation between this lesion and other common factors producing cervical radicular disturbance, such as trauma, tumor, or proliferative degenerative changes in the spine itself, seems impossible. The diagnosis must be made by roentgenographic studies or, failing that, by direct surgical exploration. The former, of course, is to be preferred.

In reviewing the roentgenographic studies of the reported cases, it becomes obvious that a diagnosis should be possible without resorting to surgical exploration. In all of the cases there had developed some means of compensation for the weakening of the cervical spine due to the anomalous development of the vertebrae. In Hadley's first case, the neural arch became more dense, and a hypertrophic bone process extended from the margin of the involved vertebral body to that above. His second patient had a heavy, bony ridge between the deficient vertebra and the one above; while in his third patient, a strong bony column extended from the vertebra above to the one below, completely by-passing the weaker vertebra. In our case, the lamina of the seventh cervical vertebra was larger than normal size on the involved side and articulated with the posterior surface of the lamina of the vertebra above. Because of the large size of this lamina and the tilt of the spine to the right, the neural arches of the fifth and seventh cervical vertebrae were in close proximity to each other. One would not expect these attempts at stabilization of the cervical spine to be present if the pedicle had been destroyed by a neoplastic process of relatively recent onset.

Fig. 1. Left posterior oblique roentgenogram of the cervical spine. The right pedicle of the seventh cervical vertebra is absent. The lamina is larger than normal on the right side and articulates with the posterior surface of the lamina of the sixth cervical vertebra. The superior facet and posterior portion of the transverse process on the right of the seventh cervical vertebra are absent. An anterior or costal portion of the transverse process remains.

If doubt remains as to the correct diagnosis, the performance of cervical myelography and vertebral arteriography should be conclusive. The most important part of the roentgen examination is a 45-degree oblique roentgenogram which demonstrates the pedicle and facets better than the anteroposterior and lateral views.

Three phases of development occur in the ontogeny of the vertebrae: a membranous or blastema stage, a chondrogenous stage, and an osteogenous stage. After the membranous stage, three centers of chondrification appear on each side of each vertebral blastema: one in each neural process, one in each side of the vertebral body, one in each costal process. A fusion of the several parts takes place, and a cartilaginous vertebra results. The transverse and articular processes grow out from the side of the neural arch. The costal processes fuse with the transverse processes and

centrum of the vertebra. As a result of the fusion, there is left a small canal between the vertebra and costal processes. This canal is traversed by the vertebral artery and is designated the "transverse foramen" (2).

It is interesting to speculate as to the stage in the development of the normal cervical vertebrae that the anomaly occurred. The posterior aspect of the transverse process on the involved side was absent in all three cases reported by Hadley and also in the case which we have presented. It appears that the absence of the pedicles and related bony structures must be due to defects of varying degree in the cartilaginous neural arch. This would explain the failure in development of the posterior portion of the transverse process, while the anterior portion, which develops from a separate center of chondrification, was present in all cases.

SUMMARY

Absence of the pedicle of a cervical vertebra probably is not uncommon. This lesion may be symptomless, but it is important that its diagnosis be established so that the possibility of a destructive lesion due to neoplasm may be excluded. It is felt that the correct diagnosis may be made roentgenologically because of the compensatory structural changes.

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SUMARIO

Falta Congénita del Pedículo y de la Faceta Superior de una Vértebra Cervical

La ausencia congénita de un pedículo y una faceta de una vértebra cervical ha recibido poca atención en la literatura radiológica, a pesar de que el fenómeno probablemente no es raro.

Preséntase un caso en el que las radiografías obtenidas en un examen verificado por sospechas de cuerpo extraño revelaron inclinación a la derecha de la porción cervical del raquis a la altura del séptimo disco intervertebral cervical y falta del pedículo derecho de la séptima vértebra cervical, dejando que se comunicaran los sexto y séptimo espacios intervertebrales, y dándoles aspecto de un solo agujero grande. La lámina de la séptima vértebra se había desarrollado sobrenormalmente del lado derecho, articulándose con la cara posterior de la lámina de la sexta vértebra cervical. Debido a la hipertrofia de dicha lámina y a la inclinación del raquis hacia la derecha, los arcos neurales de la quinta y la séptima vértebras cervicales se encontraban en íntima proximidad.

Esa lesión puede ser asintomática, pero es importante que se establezca el diagnóstico de la misma, a fin de excluir la posibilidad de una lesión destructora debida a neoplasia. Parece que cabe hacer roentgenológicamente el diagnóstico acertado, debido a las alteraciones estructurales compensadoras que ocurren.

The Radiologist in the Rural Tumor Clinic, His Problems and Opportunities[1]

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THE RADIOLOGIST is an integral part of any clinic, large or small, whose chief function is the diagnosis and treatment of tumors. In a small community, where some of the specialties may not be represented, his opinion may be the deciding factor in the choice of treatment of tumors. Such an opinion, if the patient's best interest is to be served, must be based not only upon what radiation can accomplish, but also on what can be accomplished by surgery or chemotherapy. It behooves the radiologist then to keep abreast of the advances in fields other than his own, to temper his enthusiasm for radiation with caution, to weigh the possibilities of radical tumor surgery, to use practical sense and kindness in the selection of a mode of treatment, realizing that a human being and not a laboratory animal is involved. Unfortunately, economic considerations must also enter into his choice of treatment, for many patients in a rural area lack funds for hospitalization, for transportation, for trial of expensive drugs. Lack of funds may be exceeded by superstition, by fear, by dislike of being kept away from their own homes for any extended period of time—all of which factors enter into the planning of treatment. One patient left our clinic with 50 mg. of radium on his face, just to get home in time to milk his cow!

Not only must the radiologist use care in suggesting a method of treatment; he must avoid the sin of false pride. If another clinic, within reasonable reach of the patient, affords better facilities, then the patient should be directed there. This is a fundamental principle in all of the practice of medicine, but in the care of cancer, where cure is so important, it is doubly true. Fortunately, the Georgia system of eighteen State-Aid Clinics, located in both large and small cities, often enables the radiologist in a smaller community to transfer an indigent patient to a clinic in a larger city where better treatment is available. In our own clinic, for example, all cases for neurosurgery and thoracic surgery are referred to larger clinics.

In a rural community, it is inevitable that many cases of advanced cancer will be seen. This is particularly true where there is a large percentage of Negro patients. Palliative radiation therapy has a very useful application in these cases. The radiologist must remember that prolongation of life and relief of pain are prime considerations in the management of cancer.

Clinics of any type, especially tumor clinics, attract patients who have been treated elsewhere. These patients may arrive with no record of previous treatment, or may fail to mention it at all unless thoroughly questioned. The radiologist must be very cautious about this matter, for the radiation he might add to previous treatment could be just the amount to cause irreparable damage. In this connection, every radiologist should be familiar with what modern plastic surgery can accomplish in the treatment of radiation injuries.

While the final diagnosis of cancer often rests with the pathologist, it may equally often rest with the radiologist. So myriad are the manifestations of cancer that errors are inevitable, but a radiologist who is cancer-conscious and searches for

[1] Presented at the Thirty-seventh Annual Meeting of the Radiological Society of North America, Chicago, Ill. Dec. 2–7, 1951.

[2] Director of the Americus Tumor Clinic.

these manifestations will raise the level of accuracy in the diagnosis of cancer by his group. If he reads cancer literature widely, he will be a better cancer diagnostician. Once the presence of cancer is recognized, the radiologist may perform one of his most valuable functions by demonstrating metastases, thus avoiding useless surgery and, coincidentally, useless expense.

Early in his experience, the radiologist in a rural tumor clinic will learn how dependent he is on the wisdom and cooperation of his colleagues in other specialties. The internist, who can properly evaluate the cardiac status of a cancer patient; the urologist, who can perform a thorough study of the urinary tract; the bronchoscopist, the gynecologist, the pediatrician—these and many more may guide his feet along the straight and narrow path in diagnosis. In treatment, they may clear up various conditions which would be a hindrance to the proper management of the patient requiring radiation therapy.

The atomic age has added to the problems of the radiologist in a rural community. The lay press has led many to believe that all the answers to the treatment of cancer lie in the products of the atomic pile. Hence the radiologist must keep himself informed as to the value of radioactive substances in diagnosis and treatment, in order that he may counsel wisely with his colleagues and his patients.

The above remarks touch only briefly on some of the radiologist's problems in a rural tumor clinic. In addition, he comes to live close to poverty and superstition, and to lay and professional ignorance of cancer; to know disappointment when late recurrences appear; to realize how little we really know about cancer. But he has opportunities also. He has time for the study of individual cases, for ferreting out the various manifestations of cancer, for watching clinical progress. He must personally treat his therapy cases; he must pay some attention to their physical comfort. Here he remains, as in no other field of radiology, a practising physician. He does not simply file a report and forget about these cases; he must watch them through to either cure or death. Ivan H. Smith[3] has aptly said: "One of the greatest contributions the practitioner of medicine can make in the struggle against cancer quackery is to support and relieve his hopeless, helpless cancer patients to the end." Here lies an opportunity for the radiologist to advance our specialty and to make it an integral part of the practice of medicine in his community.

There are tremendous opportunities for cancer education. By case presentations and consultations, the radiologist can stimulate interest in cancer among the physicians of his own and neighboring communities. By quiet talks with patients, he can get them to take home from the clinic the gospel that early cancer can be cured.

The close association with his patients may give him many headaches but it will also give him a deep sense of satisfaction when cancer is cured. And, should his mind and heart be receptive, he will come to recognize the fine spirit of many who, knowing they are themselves doomed, have kept a smile on their faces and a prayer in their hearts, accepting their own fate without whimpering, and spending their time in the encouragement of fellow sufferers.

Until cancer education reaches a higher degree of proficiency than it has attained today, until more physicians become cancer-conscious, until economic conditions in the rural areas are improved, then much cancer must be diagnosed and treated at the local level. I have no quarrel with the separation of radiology into diagnostic and therapeutic branches in the cities, but in smaller communities many of us must continue to work in both branches. We must do the best job we can and pray for forgiveness of our medical sins.

[3] In the Bulletin of Cancer Progress, American Cancer Society, July 1951.

To the young radiologist of today, finishing his residency and going out into practice, I know of no field that offers more exciting adventure, a greater opportunity for service, a better chance to learn early in life the lesson of humility, than to work with cancer in a rural community.

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SUMARIO

El Radiólogo en la Clínica Rural de Tumores: Sus Problemas y Sus Posibilidades

Esbózanse algunas de las obligaciones y recompensas que tiene ante sí el radiólogo que sirve en una clínica rural para tumores. Tiene que guardar constantemente en mente el bienestar del enfermo dado, contrapesando las ventajas de la radioterapia con las de otros procedimientos y prestando debida consideración a los factores económicos y personales. Tiene que familiarizarse con el problema del cáncer y con los adelantos logrados, tales como el uso de radioisotopos en el diagnóstico y en el tratamiento. Tiene además que colaborar plenamente con sus colegas de otras especialidades. Su recompensa consiste en la posibilidad que tiene de verificar intensos estudios de casos individuales, en la oportunidad de que disfruta de avivar interés en la educación en el cáncer de parte de otros médicos así como de sus enfermos, en la satisfacción de conseguir algunas curaciones y en la inspiración derivada del valor mostrado por muchos pacientes que son incurables.

A Preliminary Report on the Use of Gallium^{72} in Clinical Tracer Studies[1]

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H. B. MESSINGER, LT (MC) USNR[4], and H. C. DUDLEY, CDR (MC) USN[5]

DUDLEY (1–5) AND King (6, 7) have reported on the distribution of radiogallium in animals and on its excretion by both man and animals, while Mulry and Dudley (8), in 18 patients with radiographic evidence of malignant bone tumors, demonstrated increased deposition of gallium^{72} in the affected skeletal areas in 15. Conclusions based on these studies may be summarized as follows:

(1) Gallium^{72} is a short-half-life isotope (14.3 hours) with energetic gamma emissions (the value for Iγ is 13.3 compared with 8.47 for radium) and moderately energetic beta particles, with an average energy of 0.45 mev.

(2) Biological studies indicate that gallium^{72} has an early deposition in growing bone and that the more rapidly growing the bone the more rapid the uptake. It is excreted almost primarily by way of the kidneys, with a very small amount in the feces.

It is apparent from the data presented that this isotope might be employed as a diagnostic tracer in studying the spread and extent of certain types of bone tumor.

The purpose of this report is to present the preliminary results of a project utilizing gallium^{72} for clinical tracer studies. The objective was to evaluate this isotope as a possible diagnostic tool (*a*) in the determination of the spread of primary bone tumors to areas other than the primary site and (*b*) in the determination of the site and extent of early bone metastasis from malignant lesions in the soft tissues. The results presented here concern the preliminary part of this project, during which 72 tracer studies were performed on 63 patients. The advanced portion of the study is now under way with a simplified and improved technic and a more careful selection of patients. It is anticipated that the results will be more conclusive than those to be reported here.

A continuous study was made of a group of patients with proved cancer of a type likely to metastasize to bone. Gallium^{72}-tracer studies were repeated at three- to six-month intervals along with routine bone surveys at corresponding periods. The final evaluation cannot be made until sufficient time has elapsed for radiographic evidence of bone metastases to develop in a significant number of the patients. When this significant number is available, an attempt will be made to correlate the gallium studies with the radiographic findings.

PROCEDURE

A tracer dose (0.5 millicurie) of gallium^{72} citrate, prepared as described by Dudley (4), was administered intravenously. Counts were made by means of an end-window Geiger tube (1/2-inch diameter window with 3 1/2-mg./cm.^{2} window thickness) shielded by 1 inch of lead. The distance between the window and end of the lead collimator, or the sleeve, was 1 inch. With the patient supine, skin surface counts were made at thirty-seven points over the skeleton, as indicated in Figure 1. Counts were made at six, twenty-four, and forty-eight hours following injection. A "body background" was determined at the six-hour interval by

[1] Accepted for publication in January 1952. The opinions and conclusions contained in this report are those of the authors, and not necessarily those of the Department of the Navy.
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placing the collimator perpendicular to and at the same height as the mid-portion of the patient and parallel to the floor, at a distance of two meters from the patient. All counts were corrected for radioactive decay back to the time of administration of the radiogallium.

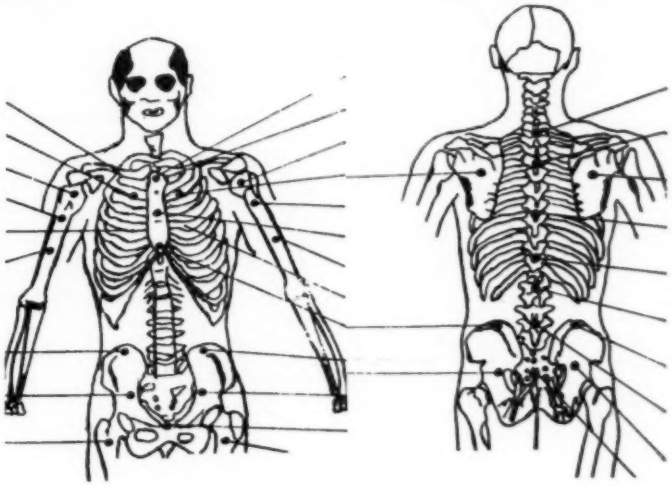

Fig. 1. Points routinely counted in radiogallium tracer studies Additional points are counted when it is deemed necessary.

RESULTS

The results were expressed as a ratio between each individual count and the "body background." Evaluation of the results of each tracer study depended on the following arbitrarily chosen standards, each of which was deemed significant: (1) points having a ratio value of over 22 in the six-hour period; (2) points having an increase in the ratio value between the twenty-four- and forty-eight-hour interval.

Thirteen of the patients studied had breast carcinoma and had undergone radical mastectomy. There were 11 cases of carcinoma of the prostate and 5 cases each of carcinoma of the cervix, malignant tumor of the testis, and carcinoma of the urinary bladder. The remaining cases comprised malignant lung tumors, carcinoma of the colon, penis, tonsil, and skin, malignant melanoma, synovial sarcoma, liposarcoma, Hodgkin's disease, multiple myeloma, and 3 metastatic tumors of unknown origin.

Fourteen patients (Table I) had definite bone metastases. Eight of this number showed increased gallium deposition in the metastatic areas, while in 3 cases the results were doubtful. In 2 of these latter cases (Nos. 12 and 19) there was involvement of one or more ribs with no other evident metastases. In 3 of the 14 patients, increased deposition in the bone lesions could not be demonstrated. Of these 3, No. 32 had a single, small lesion in the upper femur and No. 61 had involvement of the seventh cervical and first thoracic vertebra. The latter case was recently proved at autopsy to have been a case of bone erosion rather than bone metastasis.

In addition to cases with definite bone involvement by metastasis, 11 patients were demonstrated by x-ray to have hypertrophic arthritis (Table II). In some of these cases the arthritis was severe enough to mask any possible metastases. In 8 of this group, deposition of gallium^{72} was found to be definitely increased over the areas affected by the arthritis, which in every instance included the lower lumbar spine.

Five other patients had bone lesions which can only be listed as questionably metastatic in origin. In 2 of these patients

TABLE I: RESULTS OF Ga^{72}-TRACER STUDIES IN PATIENTS WITH DEFINITE BONE METASTASIS

Diagnosis	Total Points of Increased Uptake*	Increased Uptake in Metastasis Areas	Diagnosis of Metastasis by
Carcinoma of Breast			
Case 1	13–2	Yes	X-ray and autopsy
Case 5	20–4	Yes	X-ray and autopsy
Case 10	4–8	Yes	X-ray
Case 12	9–7	?	X-ray
Carcinoma of Cervix			
Case 19	9–7	?	X-ray and biopsy
Case 23	8–5	Yes	X-ray and autopsy
Carcinoma of Prostate			
Case 29	7–6	Yes	X-ray
Case 32	4–2	No	X-ray
Case 33	3–3	Yes	X-ray and autopsy
Bronchogenic Carcinoma			
Case 34	0–6	No	X-ray
Carcinoma of Large Bowel			
Case 40	0–4	?	X-ray and autopsy
Synovial Sarcoma			
Case 58	0–5	Yes	X-ray and biopsy
Malignant Melanoma			
Case 61	1–2	No	X-ray
Carcinoma of Urinary Bladder			
Case 62	4–5	Yes	X-ray and autopsy

* The first row of figures in this column refers to points with a ratio value of over 22 six hours following gallium^{72} administration. The second row refers to points with an increased deposition of gallium between 24-hour and 48-hour counts.

there was increased gallium localization at the site of involvement; 2 showed no increase, and in the other the result was doubtful.

Unfortunately, no studies could be performed on normal individuals. In an attempt to compare the above results with cases without demonstrable bone involvement, the remaining 42 tracer studies were averaged as to the total points of increased uptake per study, using standards previously mentioned. The average for these cases was 4 points for the first standard, that is a ratio value of over 22 at the six-hour count, and 4 points for the second standard, namely, an increase in deposition between the twenty-four- and forty-eight-hour count. It should be emphasized that these results were on patients with proved diagnoses of malignant tumor.

All of the patients studied showed high values over the sternum, due no doubt to its superficial position. Also, in all of the breast cases high values were obtained over the site of the original lesion. As has been mentioned, these patients had all undergone a radical mastectomy and it was recognized that the high value was probably due to the absence of the soft-tissue mass of the breast on the affected side.

TABLE II: CLINICAL TRACER STUDIES WITH Ga^{72} IN PATIENTS WITH HYPERTROPHIC ARTHRITIS IN ADDITION TO CANCER

Diagnosis	Total Points of Increased Uptake*	Increased Uptake in Hypertrophic Areas
Carcinoma of Breast		
Case 13	4–2	?
Carcinoma of Urinary Bladder		
Case 14	6–5	Yes
Case 15	5–2	Yes
Case 16	0–6	Yes
Case 18	2–6	Yes
Carcinoma of Cervix		
Case 20	17–2	Yes
Carcinoma of Prostate		
Case 25	0–6	Yes
Case 31	12–3	?
Carcinoma of Penis		
Case 42	2–6	?
Hypertrophic Arthritis		
Case 46	0–8	Yes
Benign Prostatic Hypertrophy		
Case 47	8–14	Yes

* The first row of figures in this column refers to points with a ratio value of over 22 six hours following gallium^{72} administration. The second row refers to points with an increased deposition of gallium between 24-hour and 48-hour counts.

DISCUSSION

The increased gallium^{72} deposition in 8 of 14 patients with bone metastases observed in this study does not seem as significant as the results of Mulry and Dudley (8), who demonstrated increased deposition in 15 of 18 cases. This discrepancy may be due partially to the fact that in the majority of the cases in the present study bone involvement was still in an early phase, while those cases presented by Mulry and Dudley were more extensive.

It is also to be noted that the total points of increased uptake in patients not having radiographic evidence of bone involvement are higher (4–4) than some of the similar values for patients listed in Table I. We shall not attempt to explain this variation, although it should be stated that some of the former group of patients

might at the time of study have had actual bone metastases not yet evident radiographically.

In only 1 case thus far studied (No. 10) have metastases, discernible roentgenographically, developed following gallium tracer studies. In this case gallium^{72} studies performed five months prior to the first radiographic evidence of a metastasis demonstrated increased gallium deposition in nearly all of the metastatic areas evident at the time of the writing of this article.

In those cases in which more than one observation was made there was usually a discrepancy in areas of increased deposition. This may have been due to faulty technic or to actual changes in a particular area in the as yet unknown mechanism of gallium deposition in bone.

The fact that the patients with hypertrophic arthritis showed an increase in gallium deposition over the affected areas is compatible with the accepted belief that deposition of this element is greatest in areas of increased osteoblastic activity, such as bone proliferation, areas of bone repair, and areas of rapid bone growth.

In the second phase of this study now under way, the counting technic has been changed by using a more sensitive Geiger tube with a heavier collimator which has a more acute solid angle, and counts are now being made for a longer predetermined count interval. Patient selection has also been improved, and only those types of tumor that are known to metastasize to bone in a high percentage of cases are being studied. It is hoped that these changes of procedure will produce results which will be more conclusive than those presented here.

SUMMARY

1. Clinical tracer studies utilizing gallium^{72} have demonstrated increased gallium localization in 8 out of 14 patients with definite bone metastases.

2. Eleven patients with proved malignant growth showed no definite radiographic evidence of bone metastases but did have advanced hypertrophic arthritis. In 8 of these 11 cases there was increased deposition of gallium over the arthritic areas.

3. On the basis of these results, gallium^{72} does not appear too promising as a clinical diagnostic tool. It is anticipated that further studies will present more conclusive results.

Acknowledgments: Technicians Donald J. Cummings HM2, James J. Kellner HM2, and Arthur R. Holtry HM4 deserve our gratitude for their technical assistance.

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Para el sumario en español, véase la página siguiente.

SUMARIO

Comunicación Preliminar sobre el Uso del Galio-72 para Estudios Clínicos de Despistaje

Tratando de valuar el radiogalio (Ga^{72}) como posible instrumento diagnóstico para la localización de las metástasis de los tumores óseos, verificáronse repetidos estudios despistadores en un grupo de enfermos con cáncer comprobado que se sabe mestatatiza en los huesos.

De 14 enfermos que se sabía tenían metástasis óseas, 8 revelaron mayores depósitos de galio en las zonas metastáticas, en 3 casos el resultado fué dudoso y en 3 no pudo descubrirse depósito de galio en las lesiones óseas.

Once enfermos con cáncer conocido, pero sin signos bien definidos de metástasis óseas revelaron radiográficamente que tenían artritis hipertrófica. De ellos, 8 mostraron aumento bien definido de los depósitos de galio en las zonas artríticas.

En vista de esos resultados, creen los AA. que el galio radioactivo no promete mucho como instrumento de diagnóstico.

I^{131}-Labeled Serum Albumin: Its Use in the Study of Cardiac Output and Peripheral Vascular Flow[1]

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DURING THE PAST several years a method for measuring plasma volumes has been under investigation in our laboratory (1, 2). This method involved the use of a tagged serum protein (I^{131}-tagged albumin) and gave promising results which appeared useful. It became obvious that the slow rate of disappearance of tagged albumin from the blood would make this a satisfactory substance for the study of vascular flow measurements. Before this could be achieved, however, it was necessary to develop a number of instruments which would make it possible to detect small amounts of radioactivity by their gamma emission and to record the events rapidly enough so that critical alterations in dilution and mixing of the radioactive albumin could be recorded.

The essence of the method which will be described concerns itself with measuring and recording the manner and rate in which iodinated plasma is mixed and diffused through the blood. The character of the curve which is obtained on isolated arteries has proved suitable for quantitation. The curves recorded for peripheral flow over the extremities do not as yet permit quantitation but, as will be demonstrated later, there are definite qualitative changes which may signify alterations in peripheral flow.

DESCRIPTION OF RECORDING EQUIPMENT

As intimated above, the inherent problems in measurement of any vascular flow are twofold. The first requisite is a detector sufficiently sensitive to measure and detect low levels of radioactivity by gamma emission. Since the standard method of detection, a Geiger counter, has poor sensitivity to the comparatively low-energy gamma rays of I^{131}, a scintillation counter was deemed necessary (3) and an anthracene crystal counter was adapted for this purpose. This gave an increase of sensitivity of approximately fiftyfold and made it possible for the iodinated protein to be used in tracer amounts. At the present time, thallium-activated sodium iodide crystals are being utilized and show an even greater improvement.

The second device required for adequate representation of vascular flow data was a recording apparatus that would report the concentration of the tagged atoms in the vascular system as a function of time. Since in many proposed studies of various flow channels the change in concentration during very short intervals (*i.e.*, seconds) would be of interest, it was considered that the method of withdrawing blood every one to three seconds would be both unwieldy and restrictive in respect to the total volume of blood required. Because of this, an *in vivo* system of measuring seemed desirable. Recording by an ordinary counting rate meter is possible except that the counting rate at any time is influenced by the previous count on this instrument. To avoid this so-called "memory effect," it was necessary to use a recording device capable of responding at least as fast as once per second and having each reading completely independent of the reading previously made. The instrument chosen to accomplish this was the Berkeley Counting Rate Computer. This recorder has two parallel channels,

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with each channel starting each count initially from zero and automatically shifting from one channel to another. One channel, therefore, may recover during the period that the other is functioning. The output of this counting rate computer was led into an Esterline-Angus Graphic Meter for permanent recording.

A. CARDIAC OUTPUT

The first problem to be attacked by this method was the determination of cardiac output (4) by the dilution method similar to that used by Kinsman, Moore, and Hamilton (5) and Nylin and Celander (6). This method is based on the measurement of the average concentration of the injected material as it passes through the heart. If a small volume of highly concentrated material is injected into the inflow tract, the average dilution of the material coming out from the heart will be a direct indication of the volume passing through the heart and causing the dilution. If this change in dilution is measured for a definite period of time, the output can then be expressed as volume of flow per unit time.

The general shape of the dilution curve has been discussed in previous papers (4, 5, 6) and is illustrated in Figure 1. This curve shows the characteristic rise and fall in concentration in relation to time as the large bulk of the radioactivity passes the site of measurement. The smaller rise and fall is due to the first recirculation curve, which occurs as the high-concentration surge of the first circulation has gone through the heart again and passed the site of measurement for the second time. Smaller and broader peaks for the later recirculation should theoretically be present but, as the change is small, they have not been detected. To determine the volume causing the dilution, it is necessary to record until all of the injected material has passed the counter. As the curve of Figure 1 illustrates, this is obviously impossible, because recirculation occurs before the original injection is cleared. However, since the concentration is falling off exponentially with time, the primary circulation curve may be extrapolated to approximately zero, as shown by the dotted line in this diagram. The cardiac output can then be estimated by considering the curve which expresses the manner in which the injected material is diluted.[2]

Graphically, estimation of the cardiac output may be approximated as follows: The integration of the curve representing the primary circulation and demarcated by time, T, will provide information on the average concentration during this period. This is indicated by the height of the rectangular area equivalent to area A and B as shown in Figure 1. This concentration, compared to the final concentration as represented by the final level of the curve, represents the portion of the total blood volume which must have flowed during the extrapolated time of primary circulation. For example, if the

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[2] Since the same total injected material, I, must come out of the heart as was injected into the inflow tract, this quantity of injected material must be equal to the product of the cardiac output (in terms of volume per unit time) multiplied by the concentration of the tagged material in the blood integrated over the entire time of the primary circulation. This is represented by the equation:

$$I = {}_0\int^{\infty} cF\,dt, \text{ and if } F \text{ is constant:}$$

$I = {}_0\int^{\infty} c\,dt$, where ${}_0\int^{\infty} c\,dt$ is the area under the primary circulation curve and the dotted extrapolation line. This term is equivalent to the area A and area B as shown by Figure 1. Area A may be measured by a planimeter and area B calculated by the equation:

$$B = {}_0\int^{\infty} c_b e^{-\lambda t}\,dt = \frac{cb}{\lambda}$$

where c_b is the concentration at point B and λ is the constant determined by plotting the logarithm of the concentration along line BC against time.

The output is then:

$F = I/(\mathrm{A} + \mathrm{B})$, and since the injected dose, I, is equivalent to the final dilution, c_f, multiplied by the blood volume, V:

$F = c_f V/(\mathrm{A} + \mathrm{B})$. As illustrated above and in Figure 1, the area A + B is equivalent to the rectangular area, c_{av} times T. Therefore:

$F = c_f V/c_{av} T$, which expresses the cardiac output in terms of volume per unit time.

average concentration as represented by the line c_{av} is twice the final concentration as represented by line c_f, one half of the total blood volume must have flowed during the primary circulation (T). By measuring total volume in cubic centimeters or liters, the actual amount of blood in liters or cubic centimeters may be estimated. Dividing now by time, T, the approximate time for the primary circulation to clear, will reduce the output to volume per unit time.

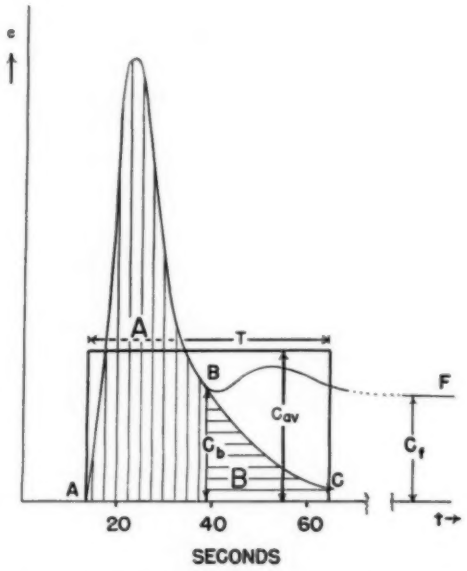


Fig. 1. General shape of dilution curve for cardiac output determinations.

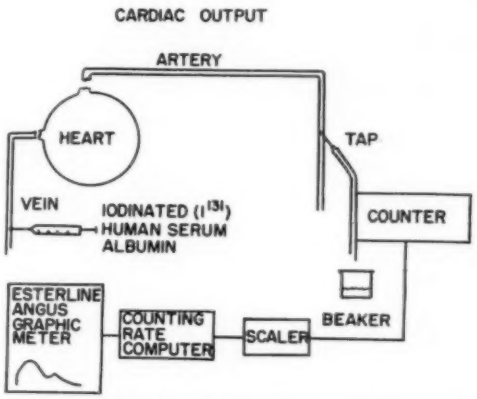
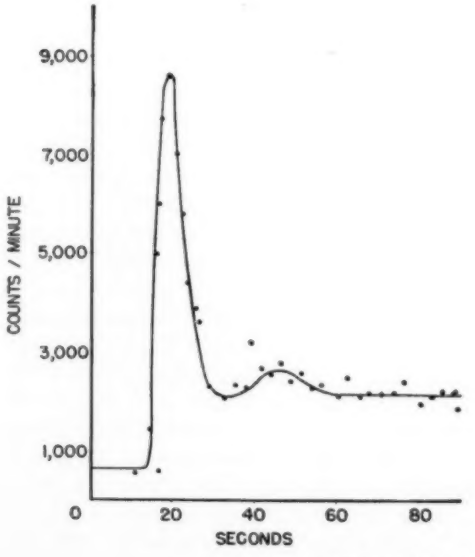
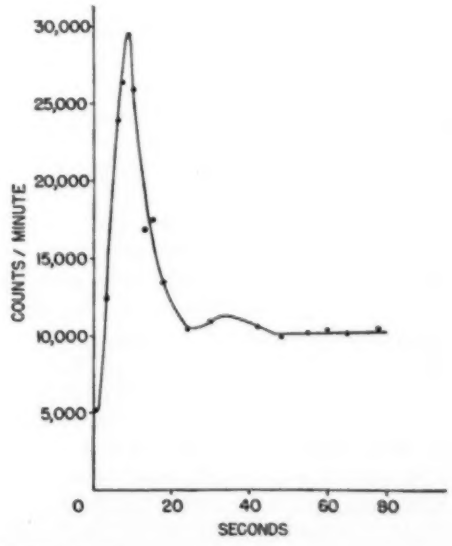


Fig. 2. Schematic experimental set-up for cardiac output determinations.

The general experimental set-up is shown in Figure 2. Approximately 150 microcuries of the iodinated (I^{131}) albumin were injected into the jugular vein in animal studies and the antecubital vein in human studies. The femoral artery was punctured and the blood led through a rubber





Figs. 3 and 4. Typical dilution curves.

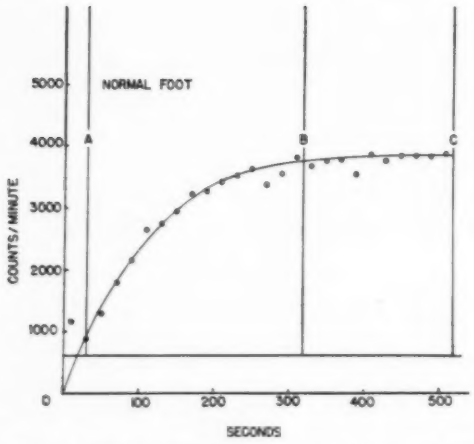


Fig. 5. Typical equilibrium curve for peripheral vascular flow measurements.

tube about 3 mm. diameter, with this rubber tubing fixed over the scintillation detector. Blood was allowed to flow through the tube into an open beaker with the rate of flow adjusted by a screw clamp to approximately 30 c.c. per minute. The dilution curve was obtained automatically as the counting rate computer fed a record of the counting rate into an Esterline-Angus graphic meter with a chart speed of 12 inches per minute. The flow system was then calibrated in terms of microcuries per cubic centimeter by comparing the final record at final dilution with the *in vitro* assay of blood withdrawn at the same time. The typical dilution curves obtained by this method are shown by Figures 3 and 4.

TABLE I: STUDY OF CARDIAC OUTPUT IN EIGHT DOGS

Exp.	Dilution Method (c.c./min.)	Direct Flow Measurement,* (c.c./min.)	Deviation (per cent)
1	1,670	1,454	15
2	1,220	1,160	5
3	1,245	1,165	7
4	1,960	1,838	7
5	1,470	1,292	14
6	960	877	9
7	1,930	1,835	5
8	2,210	1,968	12
Average deviation			+9

* Rotameter method with 5 per cent added for coronary flow.

In a study of 8 dogs wherein a comparison was made between the values of cardiac output obtained by this method and that obtained by a rotameter, the average deviation was 9 per cent. These results are shown in Table I. Cardiac outputs have been measured in 16 patients. Although the data are still preliminary, there appears to be good correlation with results obtained by the Fick method. An average deviation of plus or minus 10 per cent has been found when comparing the two methods.

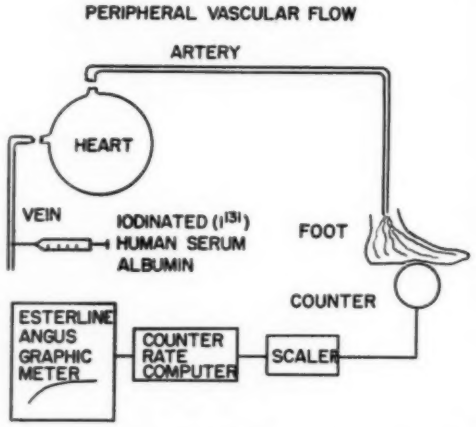


Fig. 6. Schematic experimental set-up for peripheral vascular flow measurement.

B. STUDY OF PERIPHERAL VASCULAR FLOW

Although there are many clinical approaches to studying peripheral vascular disease, few of them involve a direct measurement of blood flow in the extremities. By utilizing I^{131}-tagged albumin and the apparatus described above for cardiac output, it seemed possible to record over an extremity the rate and manner in which the tagged serum albumin and the normal serum albumin achieve equilibrium. The character of the curves which indicate the manner in which the radioactive albumin becomes mixed in the blood (in the veins, arteries, and capillaries) appears closely related to the rate of flow.

A typical curve is illustrated in Figure 5. (The latent period which is the circulation time from the arm to foot, approx-

imately twenty seconds, has been omitted from the figure.) The second portion of the curve (A-B), that showing the regular rise in activity, is a measure of the rate of mixing which is occurring in the vascular bed. It is primarily the rate at which the iodinated albumin is mixed and brought

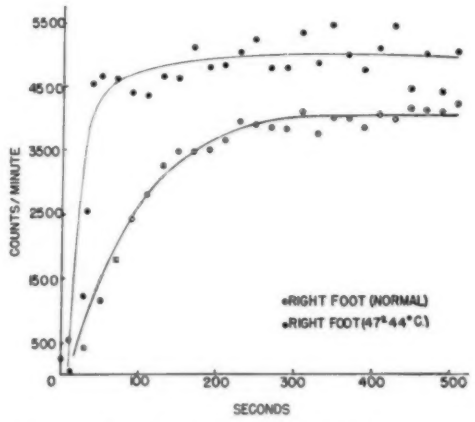


Fig. 7. Effect of heat on peripheral vascular measurement.

into equilibrium with normal plasma in the capillaries, and therefore represents the manner in which the capillary beds may be cleared. The slope of this line (A-B), which is exponential, designates the rate of this mixing. When complete mixing has occurred and equilibrium has been obtained, the level of radioactivity reaches a plateau (B-C). The final height of the plateau is indicative of the volume of the vascular bed which is measured.

Figure 6 is a schematic drawing of the method for measuring and recording the flow. Two counting devices, identical to the one described in Section A, were placed against the soles of both feet. Measurements were made with the patients in supine position with the lower extremities elevated to approximately the level of the heart. A few studies were obtained with the counting devices placed against the palmar surfaces of the hands.

An injection of 75 to 130 microcuries of I^{131}-labeled albumin was made into an antecubital vein. The injected volume

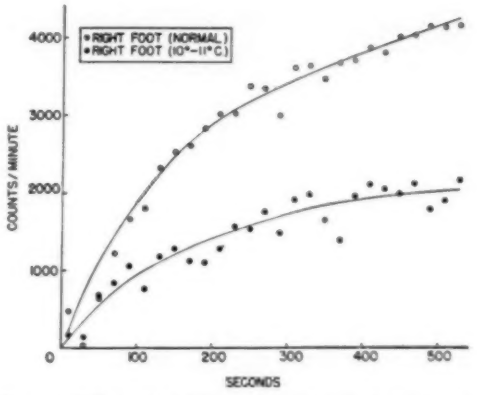


Fig. 8. Effect of cold on peripheral vascular measurement.

was kept at a minimum, usually under 1.5 c.c. The injection was given as rapidly as possible to eliminate any lag in circulation of the radioactive material. Utilizing the gamma emission from I^{131}, measurements in counts per minute were continuously recorded on an Esterline-Angus graphic meter. Measurements were made for a ten-minute period, or until a plateau of activity was reached.

RESULTS AND DISCUSSION

In any mass of vascular tissue the volume of the blood in the capillary bed far surpasses that within the arterioles and venules. Because of this, the tagged plasma in the arteries or veins is small compared to the capillary bed and the instrument therefore is measuring radioactivity primarily within the capillaries. Since the instrument is applied directly on the surface, the inverse-square law becomes important and the contribution from the radioactivity within the deep vessels falls off rapidly. It should therefore be noted here that, for the most part, the activity which is measured arises primarily from the tagged albumin within the more superficial capillaries.

In order to study alterations in the clearance rate of the capillaries and volume of the vascular bed, certain experiments utilizing heat, cold, and arterial and venous obstructions were performed. Typical

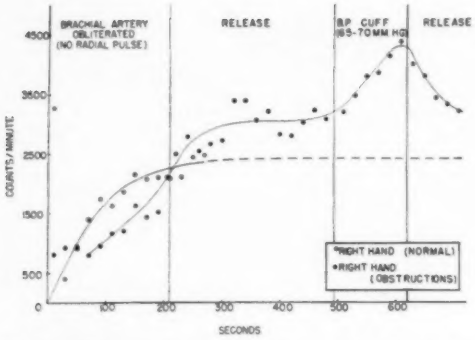


Fig. 9. Effect of arterial and venous obstruction on peripheral vascular measurement.

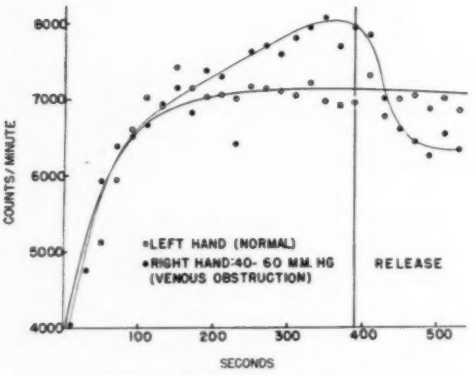


Fig. 10. Effect of pure venous obstruction on peripheral vascular measurement.

curves are shown in Figures 7 to 10. Figures 7 and 8 show the influence of heat and cold on peripheral vascular flow. Heat causes an increase in the rate of mixing due to a reduction in peripheral resistance which allows a more rapid clearing or flushing of the capillary bed. This appears to be due to dilatation of arterioles, dilatation of capillaries, or both. Cold, by producing increased peripheral resistance, has the opposite effect on the clearance rate. The volume of the vascular bed is also increased with heat, while the converse is true with cold. This is illustrated by the high plateau in the warm extremity and the low plateau in the cold extremity.

If arterial compression is produced, very little of the tagged albumin reaches the periphery and the flow curve will remain flat, as is seen in Figure 9. As soon as the obstruction is released, there is a rapid rise in radioactivity until a plateau is reached similar to that on the uninvolved side. If venous obstruction is then applied, the level of radioactivity is further increased due to "pooling" of plasma in the vascular bed. The plateau returns to normal as soon as the venous obstruction is interrupted. Figure 10 shows an

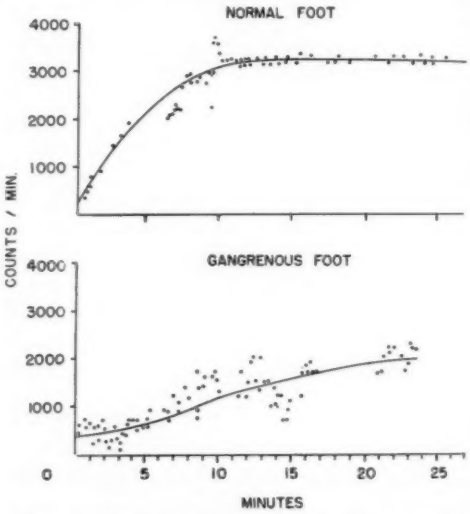


Fig. 11. Comparison of peripheral vascular uptake curves over the normal and gangrenous foot of an arteriosclerotic patient.

experiment where venous pressure was applied initially (before injection of I^{131}-tagged albumin); the rate of mixing has not altered, but the plateau has reached a higher level because of this "pooling."

A number of studies on patients with peripheral vascular diseases have been made. Figure 11 shows actual plotted data in a representative patient with arteriosclerotic gangrene of one foot. It will be noted here that there is marked reduction in the rate of accumulation of radioactivity over the diseased foot as compared with the normal, signifying reduced blood flow to the extremity, and therefore delayed mixing. The final level of radioactivity never reached that seen in the normal foot (probably due to decreased capillary volume).

On comparing the method of utilizing I^{131}-tagged protein in studying peripheral vascular flow with similar methods which have used readily diffusible electrolytes such as Na^{24} (7), the following should be noted. With a freely diffusible electrolyte, one measures not only blood flow but also diffusion rate of the electrolyte into the extracellular space. The separation of diffusion rates from actual vascular flow appears desirable and, as noted above, I^{131}-tagged albumin remaining within the vascular system well beyond the period of measurement will eliminate any complication resulting from diffusion.

Although the method for estimating peripheral flow is still preliminary and has not been evaluated for vascular diseases, it appears reasonably certain that the following statements may be made.

1. The circulation time is represented by the interval between the time of injection and the time at which radioactive albumin appears in the extremities.

2. The character and rate of mixing of the tagged albumin in the plasma appear to be primarily associated with the rapidity with which the blood in the capillaries may be cleared and replaced by blood mixed with tagged albumin. It is related to the mechanisms which directly or indirectly control capillary flow. This is represented by the slope of the line.

3. The size of the vascular bed is indicated by the level to which the curve rises and is indicative of the amount of blood which is viewed by the counter. When the vascularity is low, it is clear that there will be less blood and a lower level of radioactivity. When the vascularity is high, it is equally obvious that more of the tagged albumin will be present and the level of radiation will be considerably higher.

SUMMARY

Methods for measuring quantitatively the output of the heart and the rate of peripheral blood flow, utilizing a radioactive element, are described.

Albumin labeled with I^{131} has been adapted for these studies, since the albumin remains in the circulatory system for a considerable length of time and therefore avoids complications which arise with freely diffusible radioactive salts. This appears to be a real advantage.

The method was made possible by combining highly sensitive detection apparatus (*i.e.*, scintillation counters) with special recording equipment. The scintillation counter permits the use of comparatively small amounts of radioactivity.

The cardiac output is determined by cannulating an artery. The scintillation counter is placed in close apposition to the blood as it flows from the artery through the cannula, the recorder describing a general dilution curve. The method has been compared experimentally in animals with the rotameter method, and in man with the direct Fick method. The error appears to be approximately ± 10 per cent.

In the study of peripheral vascular flow of the extremities, an equilibration curve may be recorded by placing the counter directly over the foot. The rate at which equilibrium is achieved is, in general, a function of the peripheral flow. The level reached by the curve is a function of the amount of blood present. When modification of the peripheral vascular flow is produced, clear-cut differences may be demonstrated.

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SUMARIO

Sero-Albúmina I^{131}-Rotulada: Su Empleo en el Estudio de la Producción Cardíaca y de la Circulación Vaso-Periférica

Descríbense técnicas dedicadas a medir cuantitativamente, con la ayuda de un elemento radioactivo, la producción del corazón y la velocidad de la circulación periférica de la sangre. Tomóse para esos estudios albúmina rotulada con I^{131}, por permanecer la misma en el aparato circulatorio durante un período considerable de tiempo, evitándose así las complicaciones que surgen con sales radioactivas de fácil difusión. Esto parece constituir una ventaja real.

El método resultó factible por la combinación de aparatos delicadísimos de despistaje (espinterómetros) con una instalación *ad hoc* de registro. El cuentachispas permite utilizar cantidades comparativamente pequeñas de radioactividad.

La producción cardíaca se determina canulando una arteria. El espinterómetro se coloca en íntima aposición con la sangre al manar ésta de la arteria por la cánula, describiendo el registrador una curva general de dilución. El método ha sido comparado experimentalmente en los animales con el rotamétrico y en el hombre con el método directo de Fick. El error parece ser aproximadamente de ± 10 por ciento.

En el estudio de la circulación vaso-periférica de los miembros, puede registrarse una curva de equilibración colocando el cuentachispas directamente sobre el pie. La velocidad a la cual se obtiene equilibrio es, en general, una función del flujo periférico. La altura alcanzada por la curva es, a su vez, una función de la cantidad de sangre presente. Cuando se modifica la circulación vaso-periférica, cabe observar diferencias bien definidas.

DISCUSSION

Robert Robbins, M.D. (Philadelphia, Penna.): I should like to compliment Dr. Storaasli and his group for making still another contribution from the field of radiology to that of physiology. The principles employed in the use of iodine-labeled albumin for the determination of blood volume and of cardiac output have been available for some time and have long been used in colorimetric methods. These determinations have been facilitated by transferring the technic used in the dye studies to the radioisotope studies. The radioisotope-labeled determinations have certain advantages, in that some inaccuracies due to colorimetry have been obviated. The cardiac output determinations have been simplified by the use of radioisotope-labeled material because it avoids the necessity for taking multiple blood samples at short intervals; the future extension of this technic promises that arterial puncture may be eliminated and that the blood volumes and cardiac outputs may be determined perhaps entirely by external counting.

These studies are of great interest to the thoracic surgeon, since they provide information of great importance in the preoperative evaluation of risk, namely, the circulating blood volume and the cardiac output. It is also possible, by this same study, to detect cardiac septal defects and other cardiac shunts, and to estimate their size.

The peripheral vascular disease study is another example of the extension of a previously available tool. It is recognized that these studies have been performed before, using an electrolyte, sodium[24], in the evaluation of peripheral vascular disease. The difficulty with this material has been that it rapidly leaves the blood vessels themselves, and that capillary transport and permeability phenomena have been included in the intravascular aspect of the transport of

sodium. This difficulty is not present when iodine-labeled albumin is employed, since the material presumably does not diffuse out of the vascular tree rapidly. The newer label therefore permits a study of the vascular component alone. It is possible that the use of labeled albumin and sodium[24] successively in the same case may provide information on both the intravascular component and the capillary transport and permeability component in peripheral vascular diseases.

Bernard Roswit, M.D. (New York, N. Y.): In the Radioisotope Unit at the Kingsbridge Veterans Hospital, Bronx, New York, we have employed I^{131}-labeled serum albumin in the study of peripheral vascular flow with findings similar to those described by the essayists. However, we have had a parallel experience in the use of radioactive sodium, employing a clearance method, in nearly 350 subjects, both normal and abnormal. With this freely diffusible electrolyte, we are able to check specifically and accurately the vascular function of each particular tissue in contrast to the I^{131}-labeled serum albumin method. In addition, we have been able to use as little as 1 to 2 microcuries in 0.05 c.c. of sodium chloride solution. We are not yet prepared to report a comparison of the two methods of studying peripheral vascular flow, but such comparison will be of great interest.

A 70-mm. Cinefluorographic Camera and Its Relation to Detail[1]

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SO LONG AS THE X-ray motion picture is regarded as a supplement of the fluoroscopic examination and is judged by fluoroscopic standards, the detail and definition of the small film will not appear too unsatisfactory. Any moving object conspicuous enough to be at all perceptible on the fluoroscopic screen will be still more plainly visible on a properly taken motion picture film. Indeed the cinefluorographic record can be said to have no equal in clearing up doubtful fluoroscopic findings having to do with disturbances of swallowing, calcifications within and around the heart, and abnormal movements of the diaphragm or mediastinum.

When cinefluorography is applied to subjects outside the fluoroscopic range, and especially when it is applied to research problems, the lack of definition is not so easy to put up with. In this kind of work repeated viewing of the film as a motion picture is not enough. The investigator will want to compare different stages of the action side by side on individual frames of film. He will probably want to make tracings and measurements, and will be disappointed to find that small objects and moving contours seen fleetingly during projection are often difficult to locate when the film is examined frame by frame.

In spite of the very evident desirability of improving cinefluorographic detail, almost nothing, so far as we know, has been accomplished in this direction since 35-mm. cinefluorography was perfected by Janker of Bonn in the mid-thirties (1). The one new development that seems to promise an improvement in the interpretability of detail, if not in detail itself, is stereoscopic cinefluorography. The outcome of Janker's stereoscopic experiments, mentioned in his paper of 1950 (2), and also of the tests now being made with a remarkable stereoscopic apparatus at the University of California, Los Angeles (3), is awaited with much interest.

Another development which may eventually revolutionize the taking of x-ray motion pictures is fluoroscopic screen intensification. Morgan's kinescope recording of a 3-minute barium enema examination at average fluoroscopic x-ray intensities (4) has opened an almost unlimited range of application for the motion record. So far, however, the extraordinary increase of screen image brightness provided by such devices as closed circuit television and the Westinghouse Fluorex has not been accompanied by any corresponding increase in the sharpness of the image presented to the camera for copying. Until this condition of unsharpness has been remedied, the improvement of cinefluorographic detail as a by-product of screen image intensification must be regarded as something for the future.

Meanwhile, is there anything short of full-scale direct cineradiography that can improve detail in motion studies? One way that has been suggested is to make the cinefluorographic record on larger frames of film. To a limited extent this can be accomplished without a change of film size by increasing the vertical dimension of the standard 35-mm. camera aperture. But increasing the vertical dimension of the frame means increasing the travel of the film movement; and this in turn means building what amounts to a new camera, not to mention either a new projector or a new printer head.

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[1] From the Department of Radiology, University of Rochester School of Medicine and Dentistry. This investigation was supported in part by a research grant from the National Heart Institute of the National Institutes of Health, Public Health Service.

Presented as an Exhibit at the Thirty-seventh Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2-7, 1951. Accepted for publication in February 1952.

TABLE I: COMPARISON OF 35- AND 70-MM. RESOLVING POWER AT DIFFERENT MAGNIFICATIONS (f/1.5 Lens, Linagraph Ortho Film, Patterson E2 Screen and Patterson D Screen)

1 Approximate Size of Screen (vertical dimension)	2 Film	3 Magnification	4 Exposure Factor (70-mm.:35-mm.)	5 Lines per mm. Resolved on Screen	6 Detail Gain Factor (70-mm.:35-mm.)
Patterson E2 Screen					
14.5 in.	35 mm.	1/20	1.18	1.15	2.00
	70 mm.	1/7		2.30	
10.4 in.	35 mm.	1/14	1.25	1.45	1.72
	70 mm.	1/5		2.50	
7.2 in.	35 mm.	1/10	1.37	1.90	1.44
	70 mm.	1/3.5		2.75	
Patterson D Screen					
14.5 in.	35 mm.	1/20	1.18	1.50	2.26
	70 mm.	1/7		3.40	
10.4 in.	35 mm.	1/14	1.25	2.10	1.81
	70 mm.	1/5		3.80	
7.2 in.	35 mm.	1/10	1.37	2.75	1.51
	70 mm.	1/3.5		4.15	

Under the circumstances it seemed to us that there would be little additional difficulty, and probably some advantage, in building a cinefluorographic camera for 70-mm. rather than for double frame 35-mm. film. Our first working model of a 70-mm. film movement was constructed of easily machined materials and surprised us by handling the film satisfactorily at speeds up to 20 frames per second. Before undertaking the far more difficult final version of the camera, it seemed advisable to try to determine just how much improvement of detail could actually be expected from the 70-mm. film, and incidentally to find out whether or not an even larger film would be preferable.

MAGNIFICATION AND RESOLVING POWER

The problem of comparing 35- with 70-mm. detail is complicated by the flexible nature of the cinefluorographic apparatus. Unlike the fixed-focus mini-chest unit, the cinefluorographic unit is generally made in such a way that the distance of the camera from the screen can be varied to suit the subject. If the subject is large, an adult chest for example, the camera is pulled back until the entire screen is included in the camera aperture. If the subject is small, the camera is either moved closer to the screen, or a lens of longer focus is substituted for the regular lens. The magnification (ratio of picture size to screen size) at which the screen is copied can be varied over a considerable range. Thirty-five-millimeter units offer a range of magnifications of anywhere from 1/10 to 1/20 with corresponding screen sizes of about 7 × 9 to 14 × 18 inches. A 70-mm. unit would cover approximately the same screen sizes at magnifications from 1/3.5 to 1/7.

From the preceding paragraph it can be seen that a comparison of 35- and 70-mm. detail would be incomplete if made at only one stage of magnification. Accordingly, in Table I we have listed our experimental determinations of 35- and 70-mm. detail at three stages of magnification, that is for three sizes of fluorographic screen. The method we have used for measuring detail is the old resolving power or "lines per millimeter" method. While this method has recently been shown by Higgins and Jones (5) not to correlate very well with subjective sharpness judgments, it seemed at the time to be much the easiest method to apply to cinefluorographic detail, and is probably exact enough for our present limited purpose. The apparatus and technic used for making the determinations are those described by Van Allen and Morgan in their paper on Measurement of Resolving Power of Intensifying Screens (6).

In Table I the only factor that is varied intentionally is magnification. Lens resolving power is kept as nearly constant as possible (55 to 65 lines on the axis) by the use of three different f/1.5 lenses: two 111-mm. Fluor-Ektar lenses corrected for magnifications of 1/3.2 and 1/6, respec-

tively, and a 75-mm. Biotar lens for the smaller magnifications of 35-mm. range. Further to insure uniformity, all determinations were made within a few millimeters of the center of the field. The average resolving power for the whole field (70 or 35 mm.) is estimated to be roughly 15 per cent less than for the center, and the clines as magnification increases and as the screen grows smaller. The increasing "emptiness" of magnification is caused mainly by the progressively greater influence of screen unsharpness or blurring in close-up views, and would tend to discourage any thought of a film larger than 70 mm. for cinefluorography.

Fig. 1. On the viewing box are short lengths of 70 and 35 mm. cinefluorographic negatives and of a 16 mm. print. Height of 70 mm. frame is nearly three times that of the 35 mm. frame.

resolving power figures listed in column 5 of the table have been reduced accordingly. This somewhat arbitrary correction is based on resolving power tests of the three f/1.5 lenses made at points near the edges of their respective fields, and is applicable only to these particular lenses, which happen to have very similar relative coverage. The use of refracting lenses faster than f/1.5 would in most cases necessitate a still larger allowance for off-center unsharpness.

The superiority of 70- over 35-mm. resolving power at different stages of magnification is shown in the extreme right hand column of Table I, under the heading, "detail gain factor." It can be seen that this factor is not constant but de-

If a slightly sharper screen, the Patterson B2 or Radelin PFG, is substituted for the E2 screen, there is a slight increase of resolving power, and also a very slight increase in the detail gain factor. This trend is more clearly shown where a considerably sharper screen, the Patterson D, blue fluorographic, has been substituted for the E2 screen (Table I). We believe that these determinations are of special interest because they show so clearly the value of a sharp screen at the larger magnifications of both 35- and 70-mm. cinefluorography.

Although blue-emitting screens are nowadays generally avoided in cinefluorography because of their long persistence,

we have found that if the blue image is photographed on green-sensitive ortho instead of on the usual blue-sensitive panchromatic emulsion, no streaking of moving images due to persistence can be detected at camera speeds up to 30 frames per second. The combination of blue-emitting screen and green-sensitive film, while requiring more exposure than other screen-film combinations, can be very useful in close-up views where good detail is of special importance.

ADVANTAGES AND LIMITATIONS OF 70-MM. CINEFLUOROGRAPHY

In addition to its improvement of detail, 70-mm. film has some other advantages. The large negative is obviously much easier to study frame by frame than the smaller negative (see Fig. 1), and clearer lantern slides and illustrations can be made from it. Also the ratio of detail to emulsion grain is more favorable. Because of the practice in cinefluorography of pushing film development close to the fog limit in a five-minute x-ray developer, graininess of 35-mm. negatives and prints is frequently excessive, whereas with 70-mm. film graininess of negatives and of reduction prints on 16- or 35-mm. positives should be very nearly negligible. And finally there is the comparative ease with which the 70-mm. camera can be adapted to direct cineradiography of small moving structures.

Having reviewed the advantages of the 70-mm. apparatus, we shall have to admit that there are also limitations. Exposures, for example, must be increased when copying the screen image at the large magnifications of the 70-mm. range (see column 4 of Table I). This is the more unfortunate because there is not the same choice of fast lenses for 70-mm. that there is for 35-mm. cameras. The f/0.85 Leitz lens of 150-mm. focal length, shown in Figure 2, covers the 70-mm. frame surprisingly well, but tests indicate that its resolving power is not so good as that of refracting lenses of similar and even greater aperture for 35-mm. cameras. A mirror type lens would give the best combination of speed and resolution, if such a lens could be adapted to motion-picture work.

Fig. 2. Cinefluorographic cameras: above, new 70-mm. camera with 150-mm. f/0.85 Leitz lens; below, Bell & Howell standard 35-mm. camera with 55-mm. f/0.85 Zeiss lens. Both cameras have lead-protected, 400-ft. magazines.

As for the f/1.5 Fluro-Ektar lenses with which our resolving power determinations were made, their use will have to be restricted to easily penetrable subjects and to experimental animals, or else to very short runs and slow camera speeds. The probability is that the 35-mm. unit will still be used for many routine examinations, and the 70-mm. unit reserved for special subjects where detail is a more important consideration than exposure.

THE 70-MM. CAMERA

Although a number of 70-mm. motion picture cameras have been constructed during the past fifty or sixty years, it seems doubtful whether any of them would be entirely suitable for cinefluorography. On view at George Eastman House is one of the Mutograph cameras manufactured by Herman Casler in Canastota, N. Y., from 1895 onward. This camera was motor driven, had an intermittent of the "broken roller"

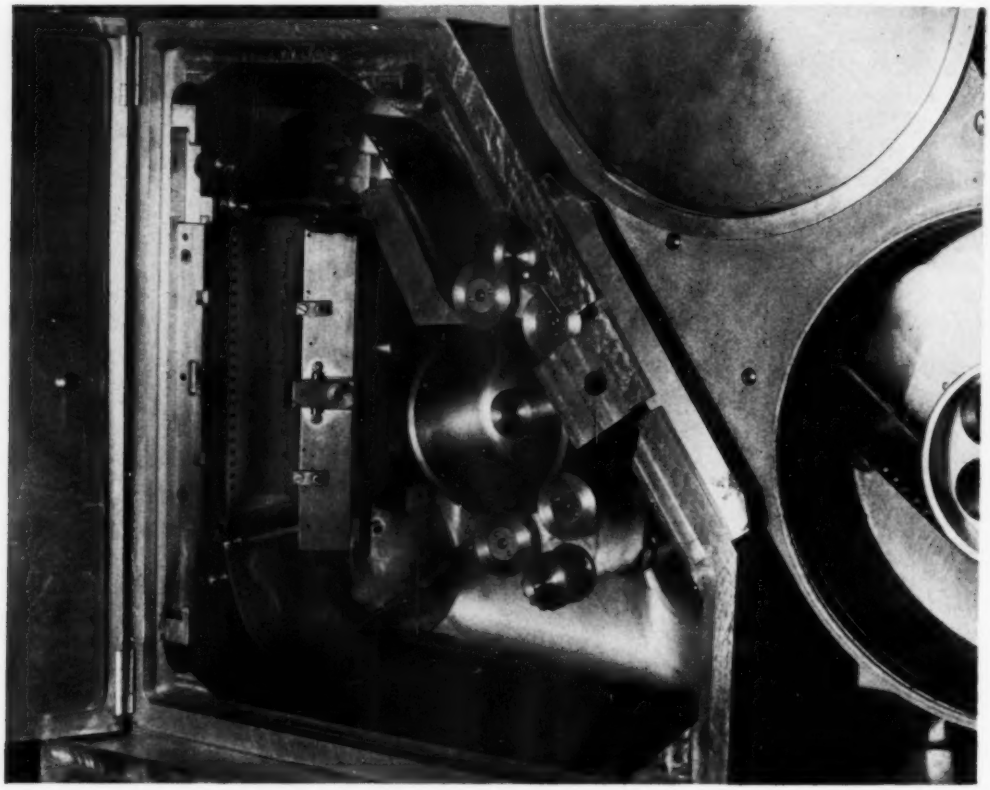

Fig. 3. Film movement of 70-mm. camera with gate open.

type, and used unperforated 70-mm. roll film, punching two register holes in each frame as it came to rest. The making of 35- or 16-mm. projection prints from such a negative would be a slow and tedious process; and, in fact, the Mutograph negatives were not printed on film but on pieces of paper for showing in Mutoscope peep-show machines.

Some thirty years later two cameras for perforated 70-mm. film were made in connection with the ill-fated Fox Grandeur Film project. Unfortunately the panoramic shape of the Grandeur frame is not well adapted to x-ray subjects.

In planning our 70-mm. camera, the design in greater part followed accepted motion-picture camera engineering principles (Fig. 3). Due to the relatively greater size of the film to be transported and positioned (as compared with 35 mm. and smaller sizes), the major problem encountered was to attain a precise focal plane positioning of the film for each exposure. In general, motion-picture films do not lie perfectly flat in the film gate during the exposure period, but have a tendency to bulge toward the lens. In frame sizes of 16 and 35 mm. this deviation from a flat plane does not generally result in out-of-focus pictures, because the relatively small size of the picture aperture minimizes the outward bulge.

However, when positioning the more than 4 1/2 square inches of picture area of 70-mm. film, the amount of outward bulge is about ten times greater than for the smaller film. In the case of the 70-mm. frame, the dome-like formation of the film may deviate from the flat plane by as much as 0.05 inch. This is more than enough to produce an out-of-focus area even with an

f/1.5 lens, which by cinefluorographic standards is a "slow" lens. Considering that desirable lens apertures for cinefluorography are in the neighborhood of f/0.85, it is readily seen that a variation of a few ten-thousandths of an inch will interfere with attaining sharp focus. The obvious solution to this problem was to incorporate a compressed-air chamber in the intermittent so that a cushion of air, formed between the rear element of the lens and the emulsion side of the film, serves not only to flatten the film against the pressure plate but also holds it firmly in register. A heavy-duty dust, oil, and moisture filter is incorporated in the air line to eliminate the possibility of damage to the camera mechanism.

Another function of the compressed air is to minimize scratching of the emulsion (a constant plague in motion-picture work). In this case, the distance between the aperture plate and the back-pressure plate was set at 0.007 inch, or 0.001 inch more than the thickness of the film. This results in the emulsion seldom coming in contact with the aperture plate. The back-pressure plate provides a perfectly flat channel of polished, hardened steel. The shuttle is designed so that the only escape for the air is through the 0.001 inch space formed between the emulsion and the aperture plate. Pressure of about 20 pounds per square inch seems to be enough to assure efficient operation at 15 frames per second.

Next in consideration of mechanical factors was the effect of the teeth of the pull-down mechanism on the film perforations. A pilot model constructed with five teeth on each side showed that fracture marks occurred where the teeth engaged the film. These marks did not appreciably alter the shape of the perforations, but as a precaution in the final version an extra tooth was added on each side, which eliminated the trouble. The teeth of the pull-down are spring-loaded and extend through the perforations just enough to give a full bearing surface (0.001 inch more than the thickness of the film). During the upstroke while the film is stationary, the rounded top edges of the teeth slide over the perforations much in the fashion of dragging a stick over a picket fence. At the start of the downstroke, the sharp leading edges of the teeth are extended into the perforations by spring action. This results in a minimal in-and-out movement of only 0.007 inch.

Fig. 4. Complete 70-mm. apparatus mounted on converted "shop lifter." Unit can be lowered to floor for use with horizontal screen.

The camera body of aluminum, without motor or lens, weighs about 60 pounds. Fully assembled on a rigid lathe bed and with the fluorescent screen assembly in place, the unit weighs about 250 pounds (see Fig. 4).

The drive is a 1/4 H. P. synchronous motor coupled to a gear box which permits a choice of film speeds of 15, 7 1/2, and 3 3/4 frames per second (Fig. 5). Film is Eastman Linagraph Ortho perforated to ASA standards. The center-to-center distance between perforations is 0.234 inch. The vertical frame dimension is 9 perforations or 2.106 inches, less 0.025 inch for the frame line. Frame width is 2.25 inches. A 70-mm. printing head is under construction which will enable the making of prints on 35-mm. or 16-mm. positive film.

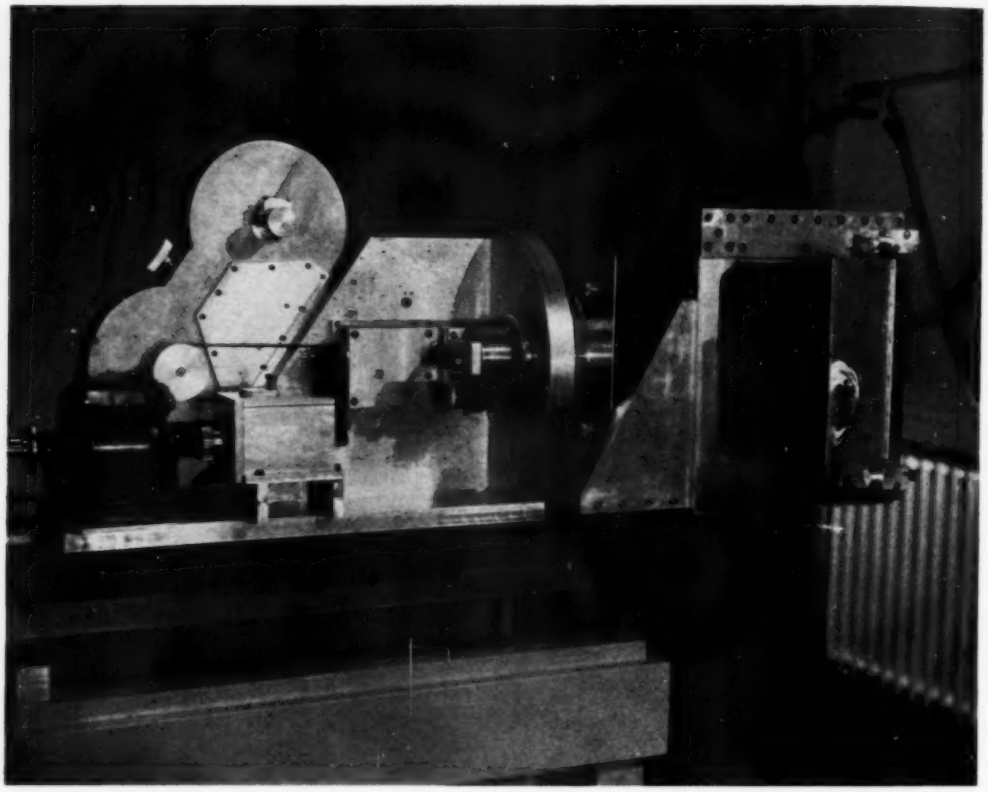

Fig. 5. Right side of 70-mm. cinefluorographic unit showing synchronous motor, gear box, triggering armature for interrupting x-ray primary circuit, and box carrying fluorographic screen in vertical position.

SUMMARY

The usefulness of x-ray motion pictures would be greatly increased by an improvement in their reproduction of subject detail. Screen image intensification systems, while contributing much more favorable exposure conditions for cinefluorography, do not at present offer a solution to the detail problem.

Resolving power tests made in connection with the development of a 70-mm. cinefluorographic camera indicate that 70-mm. detail is superior to 35-mm. detail. The 70-mm. negative is also much easier to study, frame by frame, than the 35-mm. negative.

The new 70-mm. camera has a picture aperture measuring approximately 53 × 57 mm. as compared with the 18 × 24-mm. frame of the standard 35-mm. camera. Compressed air is used to flatten the 70-mm. film in the film movement. Camera speeds of 3 3/4, 7 1/2, and 15 frames per second are provided for, although higher speeds can be reached if necessary. Prints from the 70-mm. negative will be made by optical reduction on 35- or 16-mm. positive film.

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SUMARIO

Cámara Cinefluorográfica de 70 mm. y su Relación con los Detalles

La utilidad de las películas cinematográficas aumentaría considerablemente si fuera mejor su reproducción de los detalles del tema que presentan. Los sistemas de intensificación de las imágenes en la pantalla, aunque aportando condiciones mucho más favorables de exposición a la cinefluorografía, no ofrecen por ahora solución al problema de los detalles.

Pruebas de la facultad resolvente, verificadas en relación con la elaboración de una cámara cinefluorográfica de 70 mm., indican que los detalles con 70 mm. son superiores a los obtenidos con 35 mm. La negativa de 70 mm. es además mucho más fácil de estudiar, chasis por chasis, que la de 35 mm.

Esta nueva cámara de 70 mm. tiene una abertura para fotografías que mide unos 53 × 57 mm., comparada con el chasis de 18 × 24 mm. de la cámara corriente de 35 mm. Para aplanar la película de 70 mm. en el movimiento de la película se usa aire comprimido. La velocidad de la cámara está graduada a 3 3/4, 7 1/2 y 15 chasis por segundo, aunque puede alcanzarse mayor velocidad, si es necesario. Las impresiones de la negativa de 70 mm. se harán por reducción óptica en película positiva de 35 ó 16 mm.

Magnification of Radiographic Images in Clinical Roentgenology and Its Present-Day Limit[1]

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THE PURPOSE OF the investigation to be reported here is to evaluate the relative merit of various methods of radiographic image enlargement and to determine to what degree magnification can be useful in medical radiography with present-day equipment. This study was prompted by the appearance on the market of an x-ray tube with an extremely fine focal spot (0.3 mm.), designed to produce radiographic images considerably larger than the structure to be examined.

Two reasons may be offered for enlarging a radiographic image: (1) It may be the intention to demonstrate radiographs to a large audience for teaching purposes. The projection of lantern slides and direct roentgen film projection belong in this category. (2) The desire may be to obtain more information from a radiograph than is possible by standard procedures. It is with this latter problem that the work presented here is exclusively concerned.

No one can tell who was the first radiologist to view an x-ray image through a magnifying reading glass. Though the intention of the user was obvious, his method was limited because of the inherent unsharpness of the radiographic shadows. An enlargement that reveals more detail to the viewing eye than the original is called *useful* enlargement. The maximum useful enlargement is a function of the resolving power of the entire radiographic process, embracing all stages prior to the enlargement as well as after it has been effected. At a given contrast, it is limited by the greatest unsharpness that will elude the unaided human eye.

For comfortable viewing it is necessary that the smallest detail to be seen on a radiograph be twice as large as the resolving power of the human eye, which measures 1 minute of arc or 0.15 mm. at a 50-cm. viewing distance. It is generally assumed, therefore, that the largest permissible unsharpness of an enlarged radiograph is a circle of confusion 0.3 mm. in diameter at an ordinary viewing distance of 50 cm. At this distance the human eye cannot distinguish, without strain, structures that are separated from each other by less than 0.3 mm. at ordinary illumination levels and contrast. If the smallest detail of the enlargement exceeds this value, further enlargement is useless and will yield no additional information. In short, it is useless to magnify further an image whose smallest detail is already larger than twice the resolving power of the human eye. Conversely a radiograph is capable of enlargement only if its unsharpness is lower than the maximum permissible unsharpness of 0.3 mm. The degree of useful magnification that can be obtained is thus principally determined by the ratio between the unsharpness of the original image and the maximum permissible unsharpness of 0.3 mm. of the final enlargement. In order to obtain a high degree of magnification, it is necessary, therefore, to produce radiographic images with the smallest possible unsharpness.

With a given contrast, the maximum useful enlargement is thus a function of the total unsharpness (U_t) produced by the radiographic process. It consists of the following principal components: U_g, U_a, U_f, and U_m.

U_g is the geometrical unsharpness which

[1] From the Department of Radiology of the College of Physicians and Surgeons, Columbia University, and the Radiological Service of the Presbyterian Hospital, New York. Accepted for publication in February 1952.

is produced by the finite size of the focal spot of the x-ray tube. Any point of the radiographed object will thus appear on the radiograph not as a point but as an area of blackening the diameter of which develops from the formula:

$$U_g = \text{focal spot width} \times \frac{\text{object-film distance}}{\text{object-target distance}} \quad (1)$$

U_s is the ability of the intensifying screens to record detail. Table I, which is compiled from Morgan's (12), Chantraine's (2), and Frantzell's (6) publications, illustrates well the fact that the unsharpness of many screen types is so great as to preclude any useful magnification. Only screens of the high-definition type with an unsharpness materially lower than 0.3 mm. will produce radiographs capable of enlargement. It has not been possible to date to reduce the unsharpness of fluorescent type screens to 0.1 mm.

When no screen is used, the grain of the film and the thickness of the emulsion become a factor (U_f) contributing to the total unsharpness (U_i). It may then be the factor limiting the useful magnification of a radiograph. When the resolving power of a film is expressed in lines per millimeter, this film unsharpness is:

$$U_f = \frac{1}{2 \times \text{resolving power}} \quad (2)$$

Table II contains recommendations for the selection of the proper emulsion for a desired magnification. It is based upon data issued by the manufacturer, on the authors' experience, and on measurements by Engström (4). It shows clearly that the fine-grain emulsions available to date for high magnification are so slow as to require unpracticably long exposures in medical radiography. Since film grain is smaller than the grain of fluorescent intensifying screens at present available, it can be neglected when screens are used.

Finally the factor U_m has to be considered, *i.e.*, unsharpness resulting from the relative movement of object, tube, or film.

According to Morgan (12) the total unsharpness is equal for practical purposes to its largest component. This makes it possible to neglect other factors. It is realized that this point of view is not uni-

TABLE I: SCREEN TYPE AND MAXIMAL USEFUL ENLARGEMENT BASED UPON A PERMISSIBLE TOTAL UNSHARPNESS OF 0.3 MM.

Type of Screen	Unsharpness, (mm.)	Maximal Useful Magnification (Approximate Figures)
Siemens Rubra Folie (pre-war)	0.15*	×2
Patterson detail	0.17	×1.8
Buck detail	0.23	×1.3
Buck mid speed	0.25	×1.2
Eastman Kodak high definition	0.26	×1.2
Patterson par speed	0.30	0
Patterson high speed	0.33	0
Eastman Kodak fine grain	0.29	0
Eastman ultra speed	0.32	0
Buck extra speed	0.28	0
Patterson Type D	0.48	0
U. S. Radium 666-D	0.55	0

* Estimated value. All other figures represent measured values.

Recent studies indicate that screen unsharpness varies considerably with kilovoltage and with the amount of x-ray exposure, so that no single figure can adequately express the definition of a screen. Extensive tables by Frantzell (6) contain slightly lower unsharpness values for some of the above-listed screens.

TABLE II: PHOTOGRAPHIC EMULSION AND MAXIMUM USEFUL ENLARGEMENT

Maximum Useful Enlargement	Relative Film Speed	Emulsion
× 1.5*	300	Eastman No-screen x-ray film. Code No. 5133, Double Emulsion
× 3*	100	Eastman Blue Brand x-ray film. Code No. 5121, Double Emulsion
× 10*	15	Kodak Industrial x-ray film, Type M. Code No. 5159, Double Emulsion
× 10*	15	Kodak Periapical regular dental film, Single Emulsion
× 35	6	Eastman Spectroscopic Plate, Type V-O, Single Emulsion
× 50	0.6	Kodalith Halftone, Orthochromatic Type, Single Emulsion
×200	0.03	Eastman Spectrographic Plate, Type 548-0
×300–×600	0.02–0.04	Gaevert Lipmann Emulsion (values depending on thickness of emulsion)

* If developed in regular x-ray developer.

TABLE III: THEORETICAL MAXIMAL USEFUL MAGNIFICATION OF RADIOGRAPHS OF VARIOUS PARTS OF THE BODY OF AN AVERAGE SUBJECT BASED UPON A PERMISSIBLE TOTAL UNSHARPNESS OF 0.3 MM.
(Figures are approximate. Tissue tolerance, permissible tube load, and film grain are disregarded. For selection of proper emulsion see Table II)

Anatomical Part (Taken Without Screens Unless Stated Otherwise)	Average Object-Film Distance (cm.)	2 mm. Focal Spot		1 mm. Focal Spot		0.3 mm. Focal Spot			
		Target-Film Distance (36–40 in.) or		Target-Film Distance (36–40 in.) or		Target-Film Distance			
		1 meter	2 meter	1 meter	2 meter	30 cm.	50 cm.	1 meter	2 meter
Teeth*	0.5	×30	×60	×60	×120	×60	×100	×200	×400
Fingers, toes	1.0	×15	×30	×30	× 60	×30	× 50	×100	×200
Wrist	1.5	×10	×20	×20	× 40	×20	× 32	× 65	×130
Elbow, lateral ankle	3.5	× 4	× 8	× 8	× 16	× 8	× 13	× 27	× 60
Knee, without Bucky grid	5.0	× 3	× 6	× 6	× 12	× 5	× 9	× 20	× 40
Knee, with Bucky grid	9.0	× 1.5	× 3	× 3	× 6	× 2.3	× 5	× 10	× 20
Lung, if motion is eliminated and if taken with highest definition screens (U_s = 0.15 mm.)	12.0	× 1.2	× 2	× 2	× 2	× 1.5	× 2	× 2	× 2
Lung, if motion is not eliminated	12.0	No enlargement possible							
Lateral skull, sella, AP lumbar spine with high-definition screens through Bucky grid	10.0	× 1.5	× 2	× 2	× 2	× 2	× 2	× 2	× 2
Lateral view of lumbar spine, same technic	17.0	0	× 1.5	× 1.5	× 2	0	× 2	× 2	× 2
Any part of the body taken with high-definition screens of U_s = 0.15 mm. depending on geometrical unsharpness		× 2 or less	× 2 or less	× 2 or less	× 2 or less	× 2 or less	× 2 or less	× 2 or less	× 2 or less
Any part of the body taken with high-speed screens		No useful enlargement possible							
Any part of the body enlarged *radiographically* with 0.3 mm. focus tube regardless of screen type or emulsion		No useful enlargement possible				× 2	× 2	× 2	× 2

* The average dental unit is equipped with a 1.5 mm. focal spot tube which operates at a T.F.D. of 20 cm. This permits a maximal useful magnification of ×8 for dentograms.

versally accepted. Other formulae expressing the total unsharpness have been proposed, but for the purpose of this investigation preference has been given to the Morgan formula because it affords a satisfactory degree of accuracy and simplicity. Table III gives thus the theoretical maximum useful magnification for various medical radiographic conditions based upon a maximum permissible total unsharpness of 0.3 mm. in approximate figures.

Unsharpness is not the only factor limiting magnification. In the field of microradiography, where magnifications of ×50 to ×300 are employed, the main obstacles are lack of contrast, superimposition of disturbing layers, and exposures exceeding the radiation tolerance of living tissue. Therefore, at present, microradiography is confined to the use of thinly sliced, usually devitalized specimens which have to be brought into contact with the photographic emulsion. Recently employment of high voltages (180 kv.) for this technic has resulted in a marked reduction of the necessary exposure.

Two principal methods are available for producing an enlargement of the radiographic image. One is photographic and the other is radiographic. The photographic method can be direct or indirect. In the former the radiograph, which is obtained by conventional technic, is placed in a photographic enlarger and enlarged on

photographic paper or film without intermediate steps. In the latter the radiograph is rephotographed or photomicrographed. The resulting intermediate film may be larger than the original film, in which case it bears a magnified image of the radiographed object, or it may be smaller than the original radiograph, requiring subsequent enlargement in a photographic enlarger. The intermediate film may also be a contact print of the radiograph. This reduces the unsharpness caused by the double emulsion of x-ray films. All photographic methods require the use of single emulsion films at all stages of the process if the highest resolving power is desired. By consulting Tables II and III in combination, one can determine the limit of magnification for a given radiographic problem. Anatomical parts which can be closely approximated to the radiographic film (such as teeth, fingers, and toes) tolerate theoretically extremely large magnification, but the speed of fine-grain films adaptable to such degrees of enlargement is too low to be useful. A practical compromise is the use of single-coated dental film or type M industrial x-ray film for the radiographic exploration of small anatomical parts, to be described later. This permits a useful linear enlargement of ×10. Radiographs of parts of the body which require the use of screens for their demonstration do not permit an enlargement greater than ×2.

An entirely different problem is posed by the radiographic method of enlargement. Here the magnification is achieved by increasing the object-film distance, and the magnification is the result of the divergence of the x-ray beam. According to the law of similar triangles, the magnification is ×2 when the object-film distance is equal to the object-target distance. Any point of the radiographed object will then appear on the film at least as large as the focal spot of the tube. Since the smallest focal spot available at present for this purpose measures 0.3 mm. in width, no useful enlargement is possible with this method beyond a twofold magnification. This method has the advantage, however, of being essentially independent of screen or film type.

The 0.3 mm. focal spot tube is of great potential value also to the user of the photographic enlargement method. Conventional radiographs taken with this tube may be magnified three times higher than if taken with the 1 mm. focus tube, under certain favorable conditions. It seems that the greater advantage of this tube lies in its adaptability to the photographic method or to a combination of both methods if its focal spot can be further reduced. At present, such a combination is impracticable, as shown on Figure 6. The low permissible load of 15 ma. for twelve seconds at 80 kv.—which limits the usefulness of the radiographic enlargement method—can be overcome in the photographic method by reducing the target-film distance for conventional radiographs while a moderate gain in definition over the 1 mm. focus tube is retained. When one reduces the target-film distance, the radiographic effect increases according to the inverse-square law, whereas the geometrical unsharpness rises only in approximately linear proportion if the radiographed structure lies close to the film. By operating a low-power small-focus tube at a short target-film distance, one can thus obtain, without loss of detail, shorter exposure times than with conventional tubes at conventional distances. Moreover, British physicists have shown recently that the heat dissipation from a focal spot increases considerably if its size is reduced to near point dimensions (3). High-brilliancy tubes with focal spots of 0.1 × 0.01 mm. thus constructed have an inadequate total load at present (0.5 ma. continuous operation) but seem to point the way to further development.

Another way to obtain a near point source of x-rays for the purpose of producing a radiographic enlargement is the use of a pinhole, as first described by Vallebona (13). Here the window of an x-ray tube containing a relatively large target is covered by a lead plate containing a pinhole. All x-rays striking the object which is being radiographed seem to emerge from

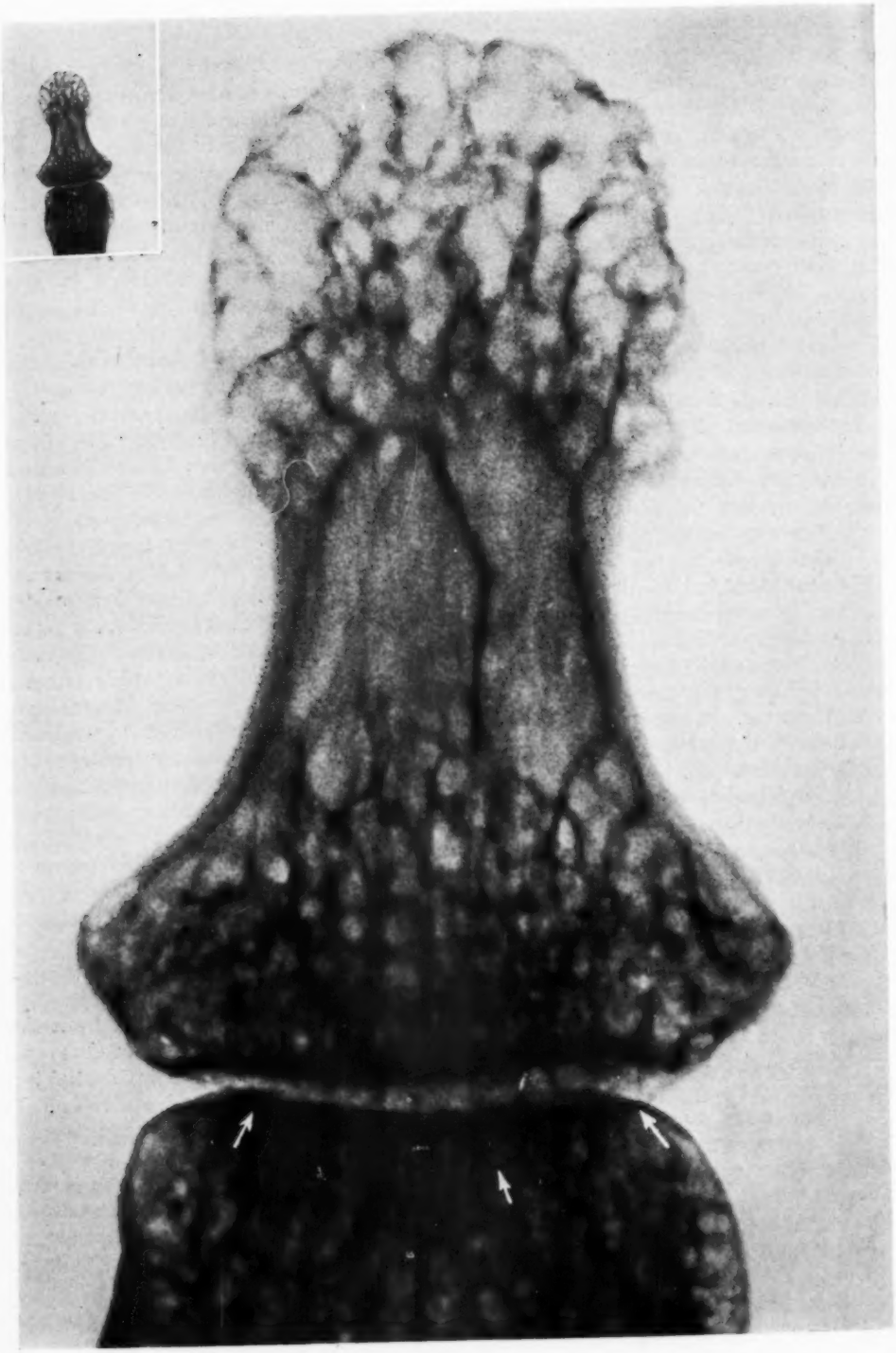


Figure 1
(For legend see opposite page)

this pinhole, producing the effect of an extremely small source of radiation. The efficiency of this method is low because most of the radiation is absorbed by the lead plate, particularly if the pinhole is small. One of the authors (G.S.S.) used a standard commercial deep-therapy machine containing a General Electric XPT tube with a focal spot of 6 × 26 mm. for this purpose. He obtained a threefold enlarged radiograph of the dry skeleton of a foot through a pinhole less than 0.5 mm. in diameter with an exposure time of 3 seconds (163 kv., 21 ma., Eastman Blue Brand film, Patterson Par Speed screens). The lead plate containing the pinhole was placed in the filter holder of the tube, which facilitated centering. A more efficient pinhole tube is that of Moon (9), used by him for electronic amplification but probably adaptable to image enlargement.

Any of the above-described methods is of value to the physician only if it can be applied to radiography of living human beings, and if it yields information that cannot be obtained from conventional radiographs. It was necessary, therefore, not only to determine the limit of optically useful magnification that can be reached with present-day equipment but also to evaluate the diagnostic possibilities that a given enlargement might offer.

Figures 1 and 2 show that a useful tenfold enlargement of radiographs is possible if the examined anatomical part is a small one.[2] It was found that single-coated Eastman "periapical regular" dental film and Eastman double-coated industrial type M film are well suited to this purpose. These film types require about 6 times the exposure necessary for the Eastman Blue Brand film used without screens, if developed in regular x-ray developer. Promicrol, a new ultrafine-grain developer manufactured by May & Baker Ltd., Dagenham, England, was also used. It did not improve the speed of any of the films on which it was tried as compared to regular x-ray developer. While it reduced their grain size somewhat, this gain was more than outweighed by loss of contrast, an important factor limiting the degree of magnification. This loss of contrast could be counteracted in part by the use of high-contrast enlarging paper or intermediate transparencies, but this difficulty increased rapidly and beyond remedy with the degree of magnification. Type M film was found to possess greater contrast than the single-coated dental film. Its double emulsion proved to be less objectionable than anticipated. Stopping down the lens of the enlarger to a relative opening of f/18 or even f/72 overcomes in part the unsharpness arising from the thickness of the film base separating the two emulsions. This practice is limited, however, because, while it increases the depth of focus, it reduces the numerical aperture of the enlarger lens and therewith its resolving power. Under extreme conditions optical coalescence of the film grain results therefore. This causes the enlargement to show loss of detail and an apparent larger grain than it would if the lens diaphragm were left open. According to Abbe (1), the resolving power of a lens expressed in lines per millimeter for green light of 550 millimicron wave length—and in approximation also for white light—is ×1,816 its

[2] Fletcher and Rowley (5) have published an eightfold enlargement of a radiograph of an ankle as their greatest enlargement. This approaches the limit of permissible geometrical unsharpness for so large an anatomical part (see Table III). From its reproduction it is impossible to judge whether its sharpness is adequate.

Fig. 1. Tenfold direct photographic enlargement and actual size contact print (inset) of the radiograph of the terminal phalanx of the index finger of a normal 46-year-old male. Superimposition of the base of the terminal phalanx over the distal end of the middle phalanx creates a fine line of demarcation (arrows) which cannot be seen on the unenlarged original. This enlargement seems to reveal detail that cannot otherwise be recognized.

Although the film grain is visible, indicating that the limit of useful magnification has been reached, the unsharpness of the enlargement appears to be lower than that in Fig. 3. This may be credited to the fact that the radiographic film used here contained a single emulsion only and that this emulsion was thinner than that of the No-screen film shown in Fig. 3.

Technic: 1 mm. focal spot, 40 inches T.F.D., 35 kv., 100 ma., 4 seconds, No-screen, Kodak dental "periapical regular" single-coated film.

Fig. 2. Eightfold photographic enlargement and actual size contact print (inset) of a postero-anterior roentgenogram of the metacarpophalangeal joint of the same finger as shown in Fig. 1. The small rounded density (arrow) superimposed upon the head of the metacarpal bone can also be seen on the unenlarged contact print but might escape routine detection. Stereoscopic films showed it to represent a sesamoid bone.
Technic: Same as film shown in Fig. 1.

numerical aperture. Table IV shows the relationship between effective aperture of the lens (from which the numerical aperture can be derived), resolving power, and maximal useful enlargement in approximate figures. It demonstrates well the low limit of useful magnification obtainable through small lens openings.

The use of low kilovoltage and filters did not produce any improvement of the radiographic contrast great enough to permit high magnification, although it prolonged the necessary exposure time undesirably. Removal of one of the two film emulsions after processing has been tried by others (5) in order to increase definition. This resulted in loss of contrast, however, emphasizing again the inescapable role of this factor.

Kodalith film produced a very fine grain even if processed in regular x-ray developer instead of in the special developer supplied by the manufacturer. (Promicrol fogged this film and had to be withdrawn from the processing of this particular emulsion.) The necessary exposure was so long here, however (*e.g.* 3,000 ma.-sec. for a finger tip), that motion of the patient caused an unsharpness which cancelled any gain obtained from the high resolving power of this material. Further work with this film had to be limited to the radiographing of motionless anatomical phantoms. It seems thus that with a tenfold linear enlargement the approximate limit has been reached for our present-day equipment and materials.

Whether or not smaller enlargements are of medical diagnostic value is as yet an unanswered question. Obviously a tenfold linear enlargement which represents a 100-fold planar enlargement will yield more information than a twofold linear enlargement which magnifies a given area merely fourfold. An enlargement of a radiograph is useful only if it reveals pathological conditions that cannot be recognized on the unenlarged film. Calcified *Trichinae* measure 0.5 mm. and less. They escape radiological detection frequently. Radiographing the masseter muscle on an intraoral film has been proposed for their demonstration. This method lends itself well to a linear enlargement of × 2 to × 4. The authors have not yet seen such a case. Detection of small foreign bodies in the eye is another obvious application of the method. The most urgent need for magnification is in connection with the recognition of miliary tuberculosis on chest films. Unfortunately the technical difficulties are particularly great here.

Figures 4 and 5 indicate that it is possible to obtain a twofold photographic enlargement of almost any good radiograph made on Kodak Blue Brand film or an emulsion of similar characteristics even if taken with intensifying screens, provided that the screens are of the high-definition type. For work without intensifying screens, Kodak Blue Brand film is recommended in

TABLE IV: LENS APERTURE AND MAXIMAL USEFUL ENLARGEMENT IN ANY PHOTOGRAPHIC PROCEDURE BASED UPON A PERMISSIBLE UNSHARPNESS OF 0.3 MM.

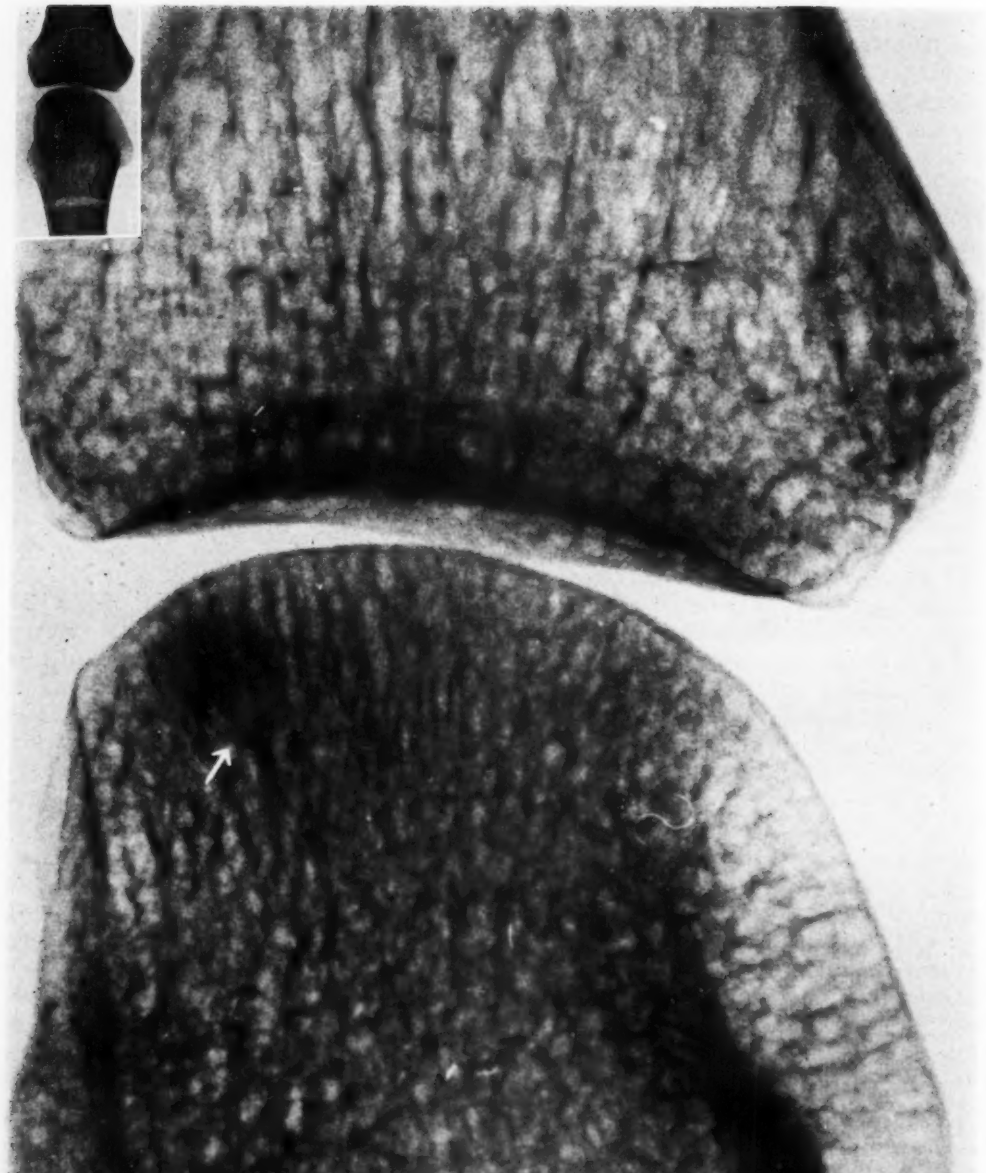
Effective Aperture of Lens of Enlarger or Copying Camera*	Resolving Power in Lines (per mm.)	Theoretical Maximal Useful Enlargement
f/2.0†	455	×270
f/4.5	200	×120
f/6.3	145	×100
f/9	100	× 60
f/18	50	× 30
f/36	25	× 15
f/50	18	× 11
f/72	13	× 8

* The effective aperture here is the distance between lens diaphragm and the radiograph to be enlarged divided by the diameter of the lens opening. In the case of a projection enlarger it approximates the diaphragm settings engraved on the lens barrel, *i.e.*, the indicated f-number is slightly lower than the effective f-number. If the enlargement is higher than ×10 the error is less than 13 per cent, if the enlargement is greater than ×100 the error is less than 2 per cent. In the case of a copying camera no such simple correlation exists. It can be calculated however according to the following formula:

$$\text{Effective f-number} = \frac{\text{Indicated f-number} \times \text{Lens-to-radiograph distance}}{\text{Focal length}}$$

A large aperture will permit a magnification of ×100 or more only if the correction of the lens is exceptional, *i.e.*, if photomicrographic lenses are employed. Ordinarily the aberrations of photographic lenses will limit useful magnification to ×30 or less. Since these aberrations increase with the lens aperture, a compromise of using a medium large opening is generally advised (f/9–f/11, if it falls within the values required by the above table).

† f/2.0 applies to low-power microscope with 16-mm. lens of numerical aperture 0.25.



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† f/2.0 applies to low-power microscope with 16-mm. lens of numerical aperture 0.25.

preference to No-screen film as shown on Figure 3, because of its finer grain (see Table II). It permits a threefold photographic enlargement provided that unsharpness due to movement or geometrical factors is sufficiently small. Viewing such x-ray films through a magnifying reading glass affording a twofold magnification is usually also quite effective. A fourfold magnification can be obtained by the use of a textile *loupe* but its visual field is so restricted that it will seldom be accepted by the radiologist.

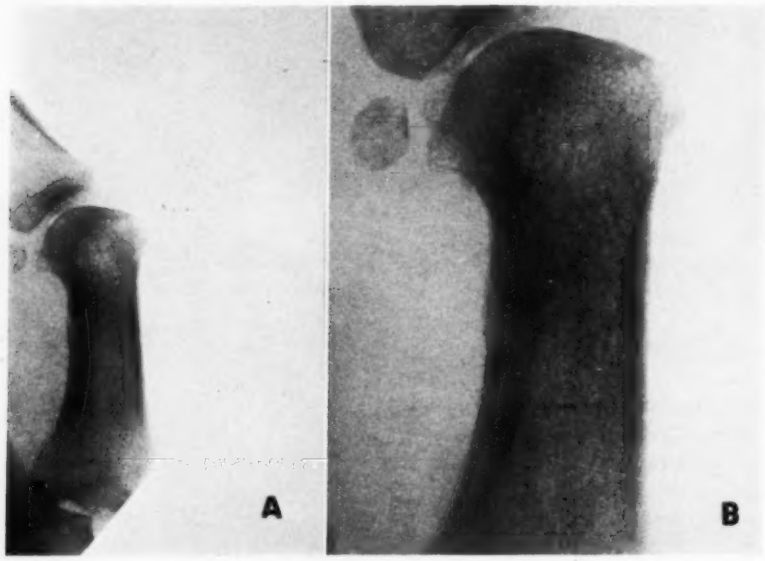

Fig. 3. Actual size contact print and twofold direct photographic enlargement of a film of the hand of a 56-year-old man with painful clubbing of the fingers, without respiratory symptoms, for nine months prior to this examination. Pulmonary osteoarthropathy had been suspected for some time on clinical grounds, but x-ray confirmation could not be obtained, and repeated chest films (elsewhere) had been reported as normal. Finally pulmonary osteoarthropathy was diagnosed from films of the femora and from the film here reproduced, on the basis of the duplication of the cortex of the first metacarpal bone. Close scrutiny of previous and present chest films then revealed a suspicious area in the right upper lobe of the lung. Resection of this lobe confirmed the diagnosis of bronchogenic carcinoma. The cortical new bone apposition was recognized on the unenlarged original film. However, the fine line separating the normal cortex from the layer of new bone cannot clearly be seen on the actual size print but is obvious on the enlargement.
Technic: 1 mm. focal spot; 40 inches T.F.D.; exposure conventional; Kodak No-screen film used without screens. The coarse grain and the thickness of the emulsion of this film produce an unsharpness here which indicates that the maximum useful magnification has been exceeded. The limit of useful enlargement lies probably closer to ×1.5 than to ×2. The film grain contributes less to the unsharpness of this roentgenogram than the diffusion of light passing through the two comparatively thick emulsions of this No-screen film.

CONCLUSIONS

1. Two principal methods of roentgen image magnification are now practical: radiographic and photographic.

2. Radiographic methods employing a 0.3 mm. focal spot tube for the taking of enlarged radiographs permit a maximal useful linear enlargement of ×2. This limit of magnification is inherent in the method.

3. This radiographic method is, at present, limited to those parts of the body which can be completely immobilized, because the small capacity of the available tubes necessitates long exposure times.

4. A photographic enlargement of ×2 is possible for radiographs of almost all body parts taken with conventional equip-

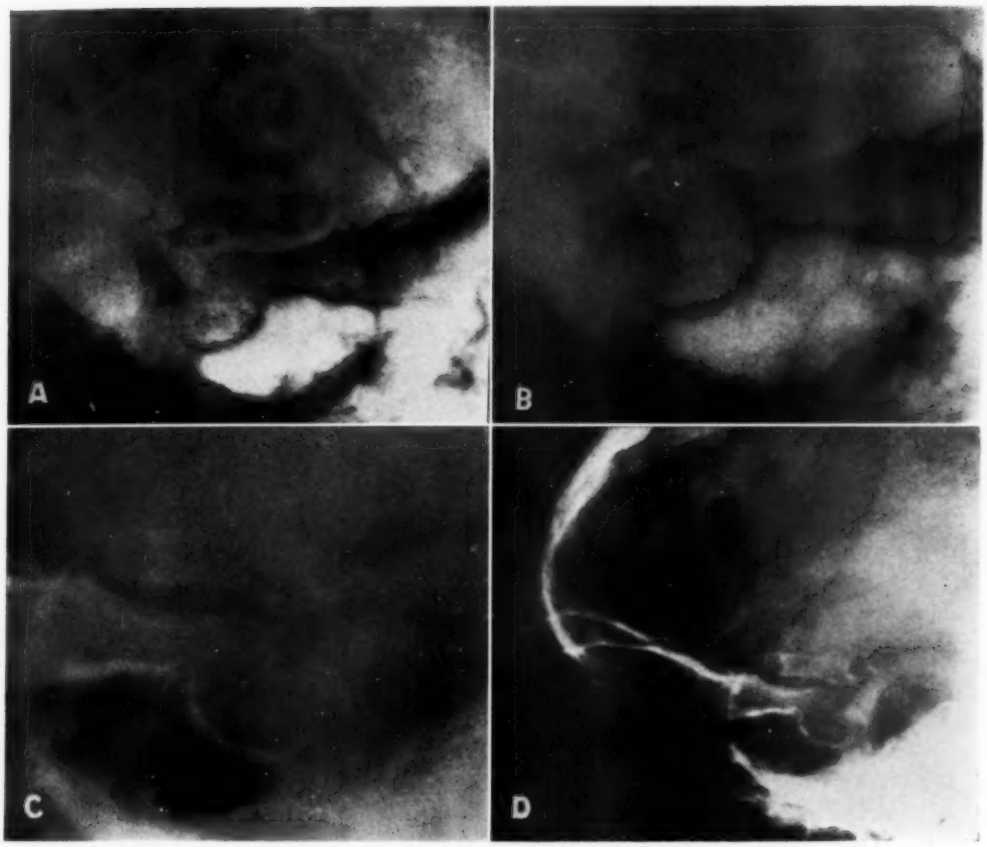

Fig. 4. Calcified anterior cerebral artery, an incidental finding in a 67-year-old woman with an untreated carcinoma of the breast with skeletal metastases. No cerebral symptoms or osseous skull lesions were present at the time of this examination. Palliative radiotherapy was instituted after this study.

A. Actual size contact print. B. Direct photographic enlargement, ×1.6. C. Indirect photographic enlargement, ×1.6. D. Indirect minification, ×1.6.

The calcified vessel can best be seen on the minified picture, D. The gain in contrast on this picture outweighs apparently any advantage that can be obtained from magnification here, as shown in B and C.

Technic: 1 mm. focal spot; 40 inches T.F.D.; Patterson Par-Speed screens; 16:1 Bucky grid; DuPont 508 film; exposure conventional.

ment, provided that the effective size of the focal spot of the x-ray tube is no larger than 2 mm. and provided that high-definition screens or a No-screen technic are used.

5. In order to obtain a twofold enlargement, neither method is necessary. The viewing of a film through a reading glass suffices.

6. The photographic enlargement method is at present the only method not limited to the above-stated degree of magnification. The maximal useful linear photographic enlargement of radiographs of the living human that can be obtained by this method with present day equipment is approximately ×10. With the development of faster fine-grain films or more powerful fine-focus tubes, higher magnifications will be possible in the future.

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ADDENDUM (17, 18)

In recent months evidence has accumulated that the effectiveness of Bucky and other grids is considerably reduced when used in conjunction with

Fig. 5. Indirect twofold photographic enlargement of the lateral roentgenogram of the skull of a three-and-a-half-year-old boy with convulsions since birth, retarded development, and blindness. Serum agglutination against *Toxoplasma* was positive. The flake-like brain calcifications, as well as the curvilinear densities in the thalamic regions, are thought to be caused by toxoplasmosis. The subarachnoid sulci are outlined by air which was introduced for the purpose of encephalography. The coarse grain of the screen reduces the merits of this enlargement.
Technic: Conventional (random film taken from the files of the X-ray Department).

radiographic magnification. This is caused by the large object-film distance necessary for production of an enlarged image by this method. It has been reported even that grids *reduce* the quality of the resulting image and are therefore undesirable for radiographic magnification (Garnes). The authors, however, find that grids definitely improve the quality of radiographic enlargements.

Experiments (to be reported at a later date) are in progress which seem to indicate that the position of the grid relative to the patient has to be altered if radiographic enlargements are to be made. To be more effective, the grid should not be approximated to the film, as is conventionally the case, but on the contrary should be brought closer to the patient in order to increase the obliquity with which scattered radiation strikes the grid! The problem is a geometrical one.

It is fortunate that part of the scattered radiation originating in the patient is absorbed by the air space created by the large object-film distance. In our experience this does not suffice, however, for dispensing with grids if optimal contrast is desired. This is particularly true in skull radiography.

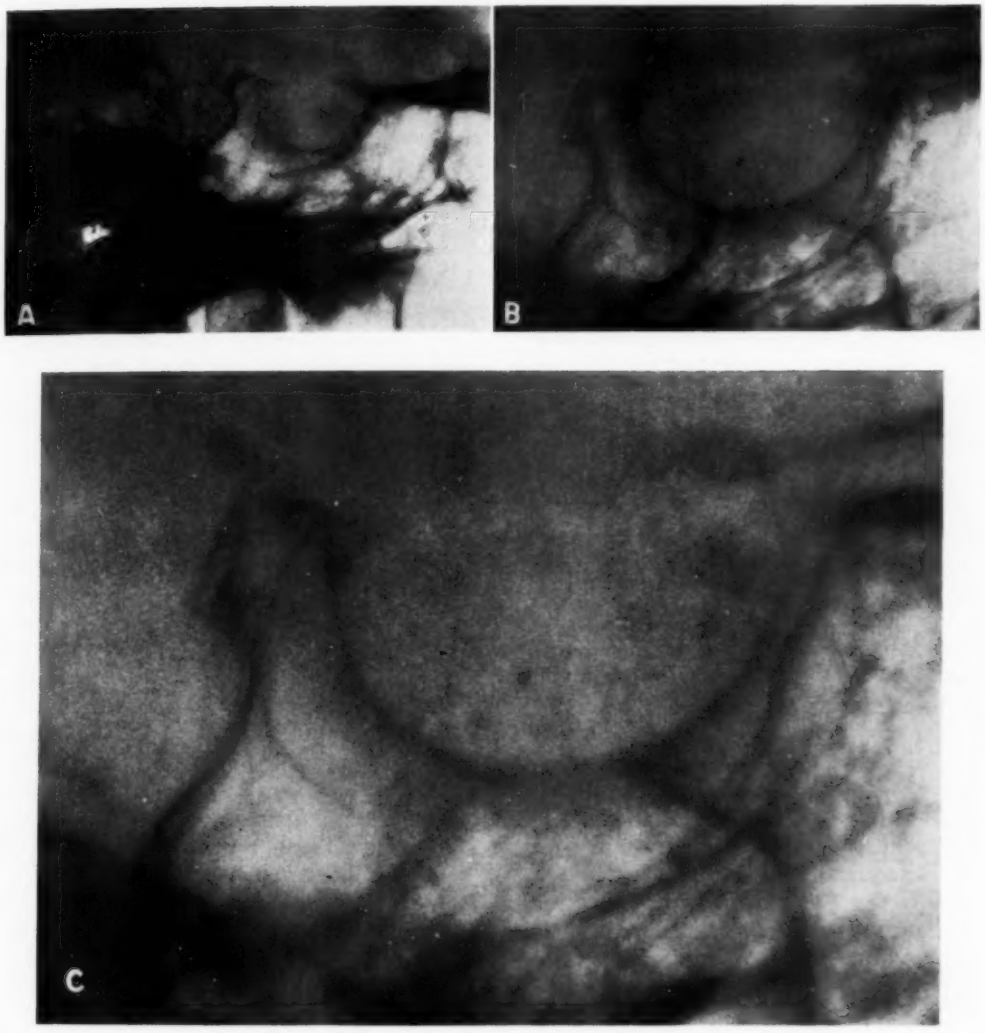

Fig. 6. Combination of radiographic and photographic magnification. Enlargement of the sella in a 37-year-old male due to a chromophobe adenoma of the pituitary gland. The lesion had been present for approximately eight years and had responded well to x-ray treatments.

A. Actual size contact print of conventional roentgenogram of skull.

B. Actual size contact print of a roentgenogram bearing a twofold magnified image of the same skull, obtained with the radiographic enlargement method by means of a fine-focus tube.

C. Twofold direct photographic enlargement of film B, representing a total magnification of ×4.

View C fails to reveal any more detail than does view B. It displays noticeable unsharpness, demonstrating the fact that a twofold radiographic enlargement is not capable of further magnification if taken with a focal spot no smaller than 0.3 mm in diameter.

Technic: Film A: Conventional lateral radiograph of skull. Film B: Radiographic enlargement produced with the 0.3 mm. focus tube, Patterson Par-Speed screens, Ansco X-ray film, 48 inches T.F.D., object-film distance 24 inches, no grid. 85 kv. 15 ma., 4 seconds. Film C: Obtained by placing a section of film B in the photographic enlarger.

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SUMARIO

La Ampliación de las Imágenes Radiograficas en la Roentgenología Clínica y sus Límites Actuales

Hoy día contamos con dos grandes técnicas que resultan factibles para la ampliación de las imágenes roentgenológicas: la radiográfica y la fotográfica.

Las técnicas radiográficas, que emplean un tubo de 0.3 mm. de punto focal para tomar radiografías ampliadas, permite un aumento lineal útil máximo × 2. Ese límite de la ampliación es inherente en la técnica. Este método radiográfico se limita, por ahora, a la reproducción de partes comparativamente delgadas o radiolucientes del cuerpo, si va a evitarse el movimiento, a causa de la poca capacidad de los tubos disponibles.

Es possible obtener una ampliación fotográfica × 2 de las radiografías de casi cualquier parte del cuerpo, tomadas con los aparatos corrientes, con tal que no exceda de 2 mm. el tamaño efectivo del punto focal del tubo de rayos X y con tal que se utilicen pantallas que permitan definición excelente o técnica sin pantalla.

A fin de obtener aumento al doble, no se necesita ninguna de esas técnicas, bastando con observar la radiografía a través de una lente de aumento.

El método fotográfico de ampliación es hoy día el único que no está limitado al aumento mencionado. Con este método, la máxima ampliación lineal útil fotográfica de radiografías de seres humanos vivos que puede obtenerse con los aparatos actuales es de unos × 10. Al elaborarse películas más rápidas de grano fino o tubos más poderosos de foco delicado, será posible conseguir en el futuro aumentos mayores.

Military Field X-Ray Equipment

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THE PURPOSE OF this paper is to inform the medical profession of the present status of military field x-ray equipment and of the current concept of military roentgenology. Since the termination of World War II, many physicians, both civilian and military, have freely contributed suggestions, valuable time, and guidance to a recently completed development program. This communication will serve as a progress report to these workers and will show that many of their suggestions and recommendations have been incorporated in the new line of field units. Characteristics of the units, which make them suitable for military operations overseas, will be discussed, and the major items will be described and illustrated.

HISTORY

The difficulty of fully anticipating requirements in a military situation is well known. Since actual needs and future changes in concepts cannot be predicted, those engaged in planning must make decisions based on past experience and the best available technical and professional advice (1). At the outset of World War II, it was believed that foreign body localization would constitute the major portion of the radiological work in forward areas and that fluoroscopy would be the method of choice (2, 3, 6). It was planned to supply films and processing equipment only to fixed type hospitals where conventional x-ray equipment would be available. This was due, to a large extent, to an anticipated film shortage. Mobile surgical hospitals were to use fluoroscopy exclusively and were equipped only with a fluoroscopic foreign body localization table, an x-ray generator, and a darkroom tent. It was estimated that only 10 per cent of the activities in evacuation hospitals would be radiographic. General hospitals were to be equipped with conventional 100- and 200-ma. radiographic and fluoroscopic units designed for the civilian market.

Contrary to original planning, fluoroscopy did not supplant radiography even in the most forward echelons. Films, processing chemicals, cassettes, and grids were demanded and supplied. The permanent record afforded by the film was considered necessary, and the surgeons wished to see the films rather than attempt to visualize the condition from a written report of the fluoroscopic examination (4, 5). Perhaps because of advances in the control of infection and of the more rapid evacuation of casualties to rear echelons, foreign body localization did not assume the importance anticipated, and most medical officers felt that the removal of foreign bodies should be done in rear areas.

In an attempt to improve facilities for radiography, many radiologists improvised rigid plywood tops for the foreign body localization table which was designed to support only a standard Army litter. They also, whenever possible, obtained Bucky diaphragms and other accessories to improve film quality.

DEVELOPMENT PROGRAM

Following the war, several meetings were held in which representatives from military, medical, technical, and commercial groups studied the problem of improving x-ray equipment for military use. The desirability of such characteristics as light-

[1] Accepted for publication in April 1952. Published under the auspices of The Surgeon General, U. S. Army, who does not necessarily assume responsibility for the professional opinions expressed by the authors.

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ness of weight, ruggedness, simplicity, and the use of standardized components had been recognized for some time. Out of these conferences came a more specific formulation of the requirements and a recommendation for the establishment of a long-range development program for the design and production of a special standardized line of military x-ray equipment available for use in future emergencies in any theater of operation.

Funds for carrying out the program were made available by the Office of The Surgeon General, and the National Bureau of Standards was entrusted with its technical supervision. The actual development of the equipment was carried out by x-ray equipment manufacturers, either under contract or on their own initiative. As a culmination of the four-year program, prototype models of most of the required equipment have now been completed and standardized. In several instances such models were submitted by more than one company and the one best suited was chosen for standardization. Certain developed items, minus many military features, have been placed on the market with permission of the sponsoring agencies. This was a material factor in stimulating tooling for mass production.

The basic unit developed for mobile medical installations is a very lightweight 15-ma., 85-kv.p. generator with a lightweight two-position radiographic and fluoroscopic table with Bucky diaphragm. A radiographic and fluoroscopic motor-driven hydraulically tilted table was designed for fixed type hospitals. This table has a simplified spot-film device and a reciprocating Bucky diaphragm, and is used with a floor rail mounted tube stand, rotating anode tubes, and a full-wave rectified 100-ma., 100-kv.p. x-ray generator of unique design.

PHYSICAL CHARACTERISTICS

Environmental conditions encountered during military operations necessitate special design and characteristics for x-ray equipment. All items must withstand transportation and storage at temperatures ranging from $-50°$ F. to $+150°$ F., as well as wide ranges in humidity. Such conditions require rust-proofing, fungicidal treatment, and use of materials not impaired by extreme climatic changes. Due to rough handling of equipment during wartime operations, exceptional rigidity is required, and specially designed packaging arrangements are necessary to afford protection against shock, moisture, and corrosive agents. Projecting parts and parts that may become detached and lost should be kept at a minimum. It must be possible to assemble, disassemble, pack, and unpack quickly all field x-ray units. Tools for emergency repair and sufficient spare parts, together with adequate instructions, should be provided to facilitate repair under field conditions. Standardization and interchangeability of all parts, such as shock-proof cable terminals and x-ray tube inserts, must be achieved. Another basic requirement of design and specification of military field x-ray units is that they shall permit the manufacture of components or complete units by any competent x-ray equipment company in order to provide alternate sources of supply. These components, made by different manufacturers, must be interchangeable as well as designed to facilitate mass production under wartime pressure.

Since the power available in theaters of operation is normally supplied by engine generators, special design is necessary to best utilize such power sources. In field operations, water supply is often inadequate for conventional film processing. This imposes certain design limitations on conditioning equipment and necessitates development of special processing technics requiring minimum quantities of water.

PROFESSIONAL CHARACTERISTICS

The medical attention given the soldier in overseas operations must be on a par with that obtainable at home. In order to furnish such high-grade medical care, professional personnel must have facilities

comparable to those normally available, with only such modifications as are necessitated by military requirements.

In fixed hospitals, combination radiographic and fluoroscopic units may closely resemble large commercial units. These units require only such changes as will facilitate shipping, assembly, disassembly, repair and replacement of worn or damaged parts. The radiologists of fixed hospitals will require films of highly diagnostic quality as well as facilities for a wide range of diagnostic procedures. For such installations, horizontal radiography and vertical radiography with cassette changer are necessary. The tube stand should permit rotation for stretcher radiography behind the table, and permit use of the horizontal beam for decubitus radiography. Instantaneous spot-film radiography, including use of a compression cone, is now considered an essential part of a diagnostic unit and is included in the present design. The table should be designed to permit fluoroscopy from a 10° Trendelenburg to the vertical position, with motor drive of sufficient power to angulate the table with the patient in place. The capacity of the fluoroscopic tube should permit continuous fluoroscopy at 85 kv.p. and at least 3 ma.

Equipment for mobile hospitals (or medical installations) is much lighter and of a more simple design, since at times it must be moved quickly and, in some instances, by hand. To achieve this mobility, some sacrifice of function is necessary, but this class of equipment nevertheless provides for essential diagnostic procedures. It should allow for vertical and horizontal radiography and fluoroscopy, without provision for spot-film radiography, but need not include intervening positions. A rigid table top, which can be changed from the horizontal to the vertical position by hand, as well as a Bucky diaphragm, is necessary. Provision must be made for non-stereoscopic and non-Bucky chest radiography, and for stretcher and decubitus radiography.

For highly mobile situations, the 15-ma., 85-kv.p. tube transformer head, control, and tube stand without the field table may be hand-carried. These lightweight units would be especially useful with the newly developed self-processing film packs of the Land-Polaroid type. Since the base of the tube stand is equipped with casters, it may also be utilized as a bedside unit in fixed installations.

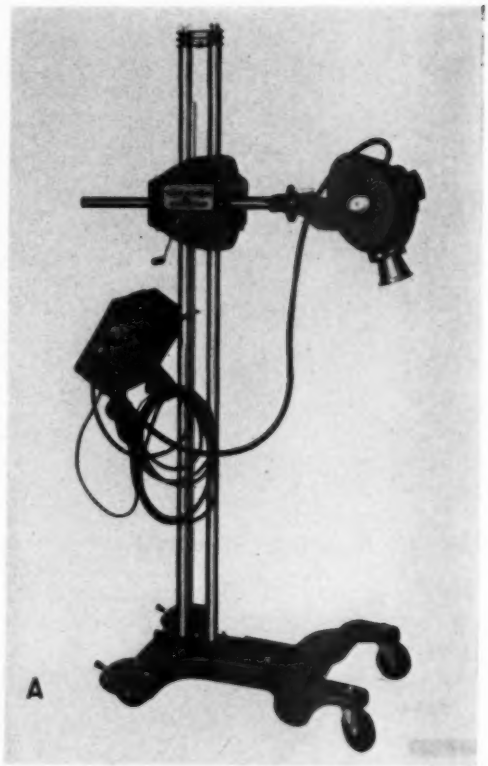


Fig. 1. A. Assembled 15-ma., 85-kv.p. portable field x-ray unit.

SPECIFIC ITEMS OF EQUIPMENT

1. The lower-powered x-ray unit, sufficiently light to allow hand portability, was designed for highly mobile use with the lightweight table and for bedside use with a simple tube stand. This unit is shown in Figure 1A–1D. The transformer contained in the tube head is conservatively rated at 85 kv.p. and 15 ma. and has a continuous fluoroscopic rating of 5 ma. at 85 kv.p. The oil-immersed sta-

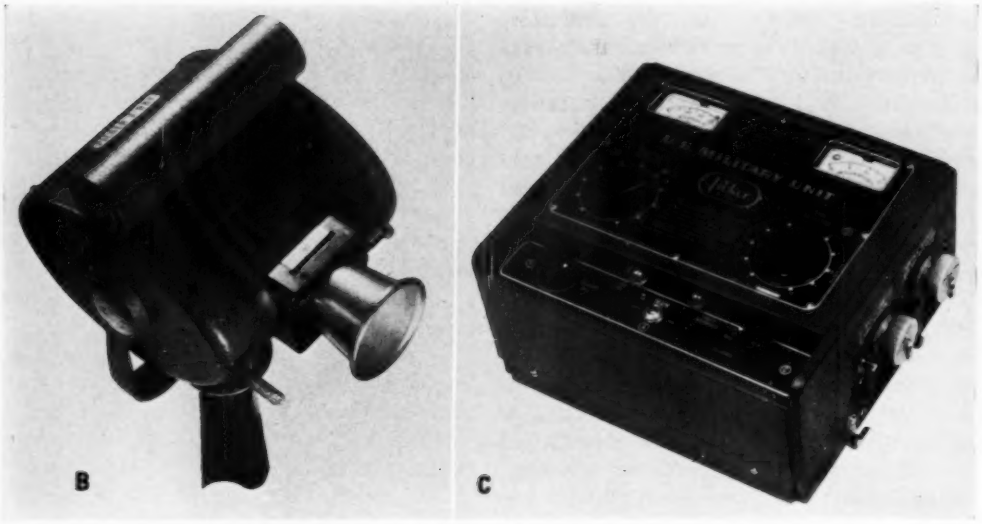


Fig. 1. B. . Blower-cooled tube transformer head showing the large oil expansion chamber. C. Control for the portable unit.

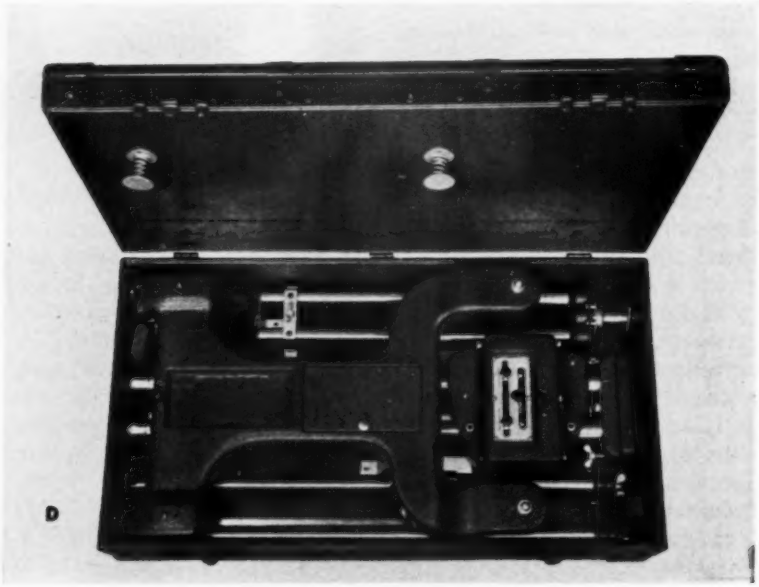


Fig. 1. D. Portable tube stand packing arrangement.

tionary anode tube has a 2.3 mm. focal spot, and the housing is designed so that the tube insert can be readily replaced.

The blower-cooled tube head is of rounded contour to facilitate positioning. Its yoke allows attachment to both the lightweight table and the portable tube stand. The mounting base for cones will accommodate all cones used with the field equipment, and has a 0.5 mm. aluminum filter and a slot to accommodate additional filters.

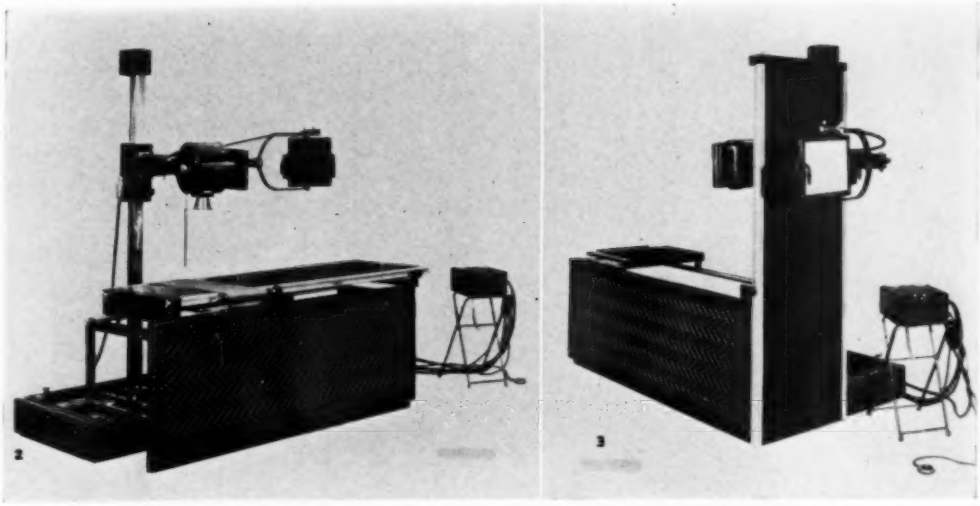


Fig. 2. Lightweight two-position field x-ray unit arranged for radiography with 15-ma., 85-kv.p. generator.
Fig. 3. Lightweight table arranged for vertical fluoroscopy.

The lightweight unit control has a line adjuster switch allowing operation from 90 to 240 volts, 50 or 60 cycles A.C., and requires 2 kv.a. power. All knobs and switches are recessed. Meters are rubber mounted and covered with transparent plastic to prevent damage. Neon lights are used to indicate when line current is on and when the heat storage capacity of the tube head has been reached.

The control is arranged for operation at a fixed value of 15 ma. for radiography and a variable current of from 3 to 6 ma. for fluoroscopy. In contrast with the field unit of World War II, the components within this control are made fully accessible for servicing by removal of only four screws. The fuses are of the plug-in type and can be replaced from the outside of the control. Circuits are provided for operation of the simplified lightweight reciprocating Bucky diaphragm. A filament voltage stabilizer and interconnecting cables with quick-disconnect terminals are additional unusual features in this type of equipment.

The light portable tube stand is constructed of a cast aluminum base, equipped with large casters, and a double tube column which supports the hand-cranked elevating mechanism of the tube carriage. The tube column, fixed against rotation at its base, increases stability and provides sufficient vertical adjustment for aligning the tube head under litters and over hospital beds. The tube stand is packed in one chest, and the tube head, control, cables, and accessories in another. Both are sufficiently lightweight to allow hand transportation.

2. The lightweight field table has the unusual feature of forming its own packing case, thus eliminating the necessity for special packaging. This table provides for horizontal and vertical fluoroscopy, for horizontal radiography with a Bucky diaphragm, for lateral radiography without moving the patient, and for stretcher radiography. It is also arranged for vertical chest radiography by use of a separate wall tunnel or the tilting panel of the table unit. Figure 2 shows the table arranged for radiography; Figure 3 shows it arranged for vertical fluoroscopy.

The front panel of the table, used as the top of the packing case, is of rigidized aluminum construction with lead protection over the center third of the panel. The base of the table, containing the box-shaped part in which the base of the tube

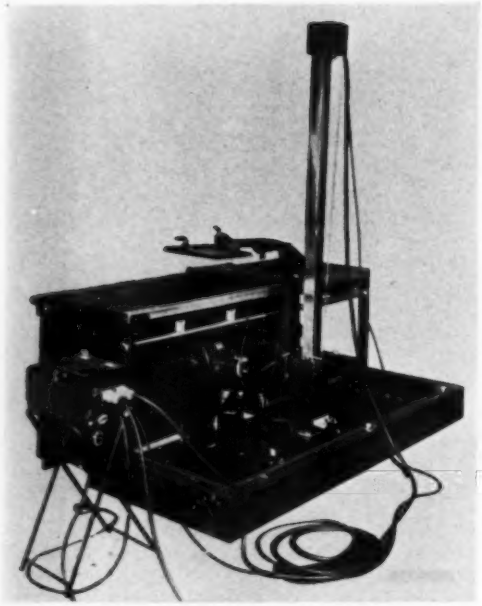


Fig. 4. Lightweight table arranged for horizontal fluoroscopy, showing cross and longitudinal travel carriage mounted in packing case base.

stand rides to provide for longitudinal and transverse motion, serves as the packing chest into which components can be packed securely. Figure 4 is a view of this arrangement. The spring counterbalanced tube column breaks in the middle for ease in packing and supports the tube carriage and the fluoroscopic screen arm. The reciprocating Bucky, weighing only about 20 pounds, is of simplified design and slides along rails which form a part of the table framework. The plywood table panel is arranged to slide along the table for about 2 feet to provide for additional table coverage. The panel is also arranged to tilt into the vertical position at the foot end of the table for vertical fluoroscopy. The tube mounting bracket and the fluoroscopic screen are pivoted to allow the tube unit to be placed under or over the table. The spring counterbalanced fluoroscopic screen is arranged in such a way that the counterbalance is effective for horizontal fluoroscopy only. The mounting bracket for the rotating anode tube used with the 100-ma. x-ray unit is interchangeable with that of the 15-ma. tube head, thus materially extending the range of usefulness of the lightweight table. With the table panel removed, a stretcher may be placed on the table frame for stretcher radiography, or the tube stand may be rotated 180° for stretcher radiography at the rear of the table.

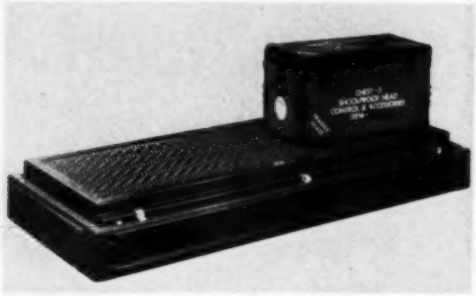
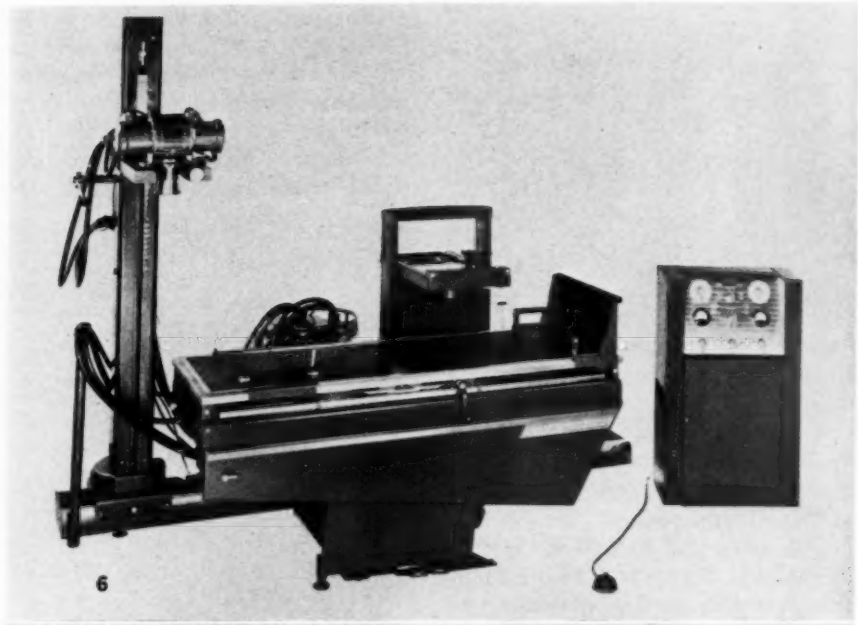


Fig. 5. Complete field table and 15-ma., 85-kv.p. generator packaged.

The construction of this unit is such that assembly, or disassembly and packing for transportation, can be done in less than fifteen minutes. Special attention has been given to making the unit rugged. Field tests, in which the table unit was repeatedly dropped from a moving truck without seriously affecting its usefulness, have proved the unit's ruggedness of construction. Figure 5 shows the equipment packed for shipment.

3. Figure 6 shows the hydraulic motor-driven tilt table, tube stand, rotating anode tube, and 100-ma., 100-kv.p. x-ray unit, and Figure 7 shows the tilt table arranged for vertical fluoroscopy and spot-film radiography. This tilting fluoroscopic and radiographic table and tube stand are fabricated of steel. The design, however, is such that the table may be constructed of either aluminum or steel. An hydraulic motor-driven mechanism tilts the table at controlled variable speeds, and provides for a range of position from 10° Trendelenburg to vertical. The table is equipped with a reciprocating Bucky diaphragm of the conventional type and a simplified manually operated spot-film tunnel. This spot-film tunnel is equipped



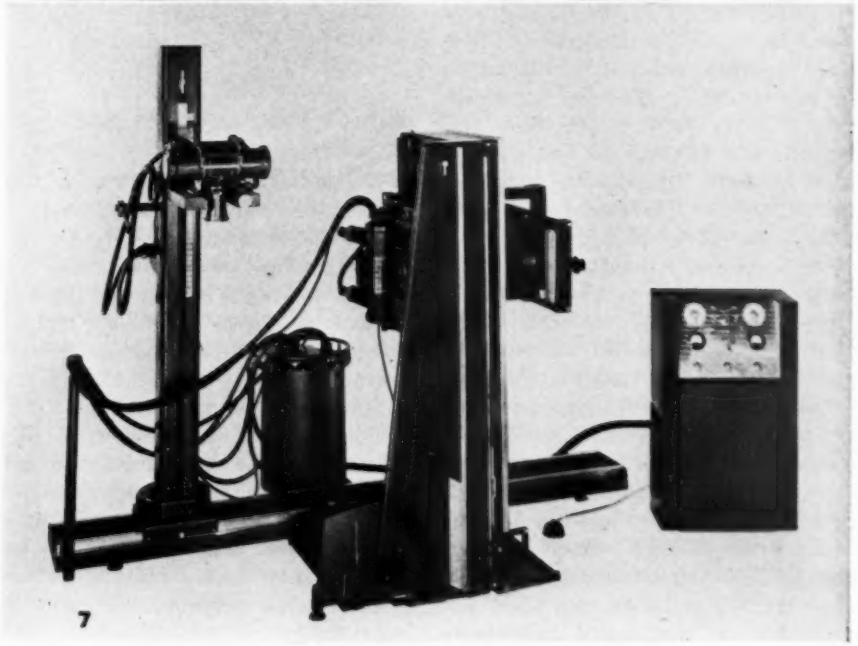


Fig. 6. Hydraulic motor-driven tilt table, tube stand, rotating anode tube with 100-ma., 100-kv.p. x-ray unit.

Fig. 7. Tilt table arranged for vertical fluoroscopy and spot-film radiography.

Fig. 8. Sulfur hexafluoride gas-filled 100-ma. transformer and reusable packing case.

with a 12 × 12-inch moisture- and fungus-proof all-plastic fluoroscopic screen, and is arranged to make one, two, or four radiographs on a single 8 × 10-inch film. A compression cone and a removable grid, which may be used for either radiography or fluoroscopy, are provided. A foot rest and shoulder support, compression device, and other accessories are also supplied with the table. The floor rail of the tube stand is attached to the table for rigidity and the tube column is weight counterbalanced and arranged to rotate about its axis. It is provided with an automatic stereoscopic shift for vertical chest radiography and pivots to obtain the longitudinal stereoscopic shift. The tube carriage provides for cross-table shift and is arranged so that the tube can be angulated about either of two axes.

4. The 100-ma., 100-kv.p. transformer unit differs from conventional equipment in that it utilizes a gas, sulfur hexafluoride (SF_6), as an insulating medium instead of the conventional transformer oil, thus saving about 150 pounds in weight. This non-inflammable, odorless, non-toxic gas has approximately five times the density of air and has the further advantage that its insulating properties are not greatly affected by slight contamination with air. The gas is used at atmospheric pressure so that the usual problems of high-pressure containers are not encountered. If the insulating gas is lost and a new supply is unavailable, transformer oil may be used as the insulating medium. Figure 8 shows the transformer unit with its reusable packing case.

The four rectifying valve tubes utilized in the transformer are designed for use

Fig. 9. Control and packing case for 100-ma., 100-kv.p. unit.

in gas and are sufficiently rugged that they may be left in place during transportation. The transformer is, therefore, ready for immediate operation upon connection with the control and tube units. In case of damage to valve tubes, the transformer can be used with two valves for half-wave operation, and without valves for self-rectification at reduced ratings.

The control unit shown in Figure 9 utilizes aluminum wherever possible to reduce weight, and is equipped with recessed carrying handles so that it can be carried short distances by two persons. For maximum accessibility, the rear panel is removable, exposing the major components of the control. The two side panels are likewise removable, permitting easy access to accessory circuits. The interconnecting cables, between transformer and control, are equipped with quick-disconnect terminals which can be attached to the control without removing

the panels. A fluoroscopic timer, with a range of five minutes, and a synchronous timer, having a range of one-twentieth to fourteen seconds, are provided. The kilovoltage is adjustable in 2-kv. steps from 40 to 100 kv., and the technic selector provides for three fixed values of current,

Fig. 10. Cassette storage chest.

100 ma., 50 ma., and 25 ma., and a fluoroscopic position with adjustable milliamperage. The kilovoltage selector is direct-reading in kilovoltage, regardless of the milliamperage selected, both for the radiographic kilovoltages and for fluoroscopy. The control panel is illuminated from both sides through translucent plastic covers, with a white light for radiography and a red light for fluoroscopy. The combination kilovolt meter and line compensator meter is provided with detachable leads to permit its use as a test meter for servicing and trouble shooting. A duplex convenience outlet for 115 volts, A.C., located at the rear of the control is provided for use in servicing.

Since this control and the 100-ma., 100-kv.p. gas-insulated transformer will be used with the lightweight field table in mobile situations, it is necessary that provision be made for operation on power generated by gasoline engines. The present line of engine generators available for medical use is of the regulated type in which there may be a delay of up to three seconds upon sudden application of the x-ray load before the voltage and frequency of the alternating current power become stable. Thus, for short exposures, the radiographic effect will not be strictly proportional to the duration of the exposure. In order to avoid this voltage instability, provisions have been made in the control for the momentary introduction of a dummy load prior to exposure. Likewise, the fluctuation in frequency of the engine generator necessitates the utilization of a non-sensitive electronic filament voltage stabilizer.

5. The rotating anode tube unit is so constructed that transportation and storage at temperatures as low as $-50°$ F. are allowed. It is also designed to operate properly both with the large tilting table and with the lightweight field table. The tube unit, cooled by means of a blower, is equipped with an extensible measuring scale. The tube insert has a solid tungsten disk with a 1.5 mm. focal spot, an anode heat storage capacity of 72,000 heat units, and is rated at 100 kv.p. 100 ma. for five and a half seconds. The tube unit includes the housing and has a heat storage capacity of over a million heat units, and a cooling rate of 25,000 heat units per minute, with the blower in use. It therefore has ample capacity, with a large safety factor for all technics possible, and the small focal spot permits high quality radiography. The tube housing is equipped with standardized shock-proof cable terminals, thoroughly tested and accepted as Federal Standard, as well as for Department of Defense use. Standardization of components, including tube inserts as well as shock-proof cable terminals, may prove to be one of the most important accomplishments of the military x-ray equipment program.

6. The following accessory items have been developed for use with the field equipment:

(*a*) Figure 10 is a view of the chest provided for the temporary storage of loaded cassettes in the radiographic room.

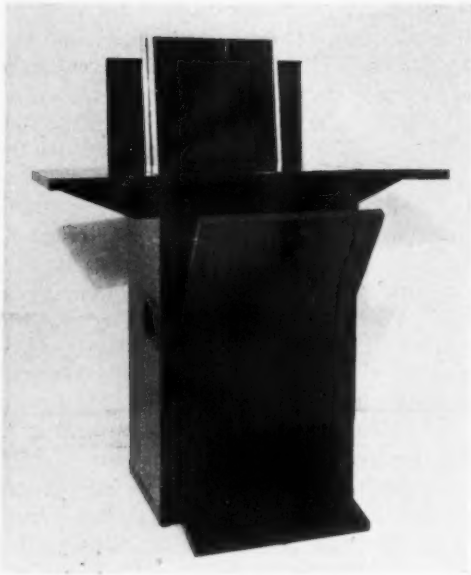


Fig. 11. Film storage and loading bin with extensible shelves.

This storage chest, equipped with an effective spring-counterbalanced lid, may also be used as a packing case in transportation. To reduce weight, it is provided with only enough lead to protect films from scattered radiation.

(*b*) Figure 11 shows the combination film storage and loading bin, equipped with hinged shelves which can be used to extend the working space of the unit top. A folding cassette rack is provided at the back, and the space below the film bin is available for storage.

(*c*) The film dryer utilizes recirculating heated air to make the most efficient use of heat in drying films. By uniform distribution of the air flow over the films, drying time has been reduced to a normal value of less than forty minutes for 18 films, without the use of wetting agents. The dryer is constructed of aluminum-clad plywood to provide adequate strength and sufficient lightness.

(*d*) The cassette pass box, for the transfer of cassettes between the radiographic room and the dark room, is of a design similar to commercial units, but is equipped with carrying handles, and is arranged for installation into the darkroom tent wall.

(*e*) The darkroom tent is of an umbrella type, the framework of which folds into a compact unit, and is arranged to accommodate either of two types of covering. One heavier weatherproof covering is used when the tent is employed for film processing; a lighter opaque canvas cover-

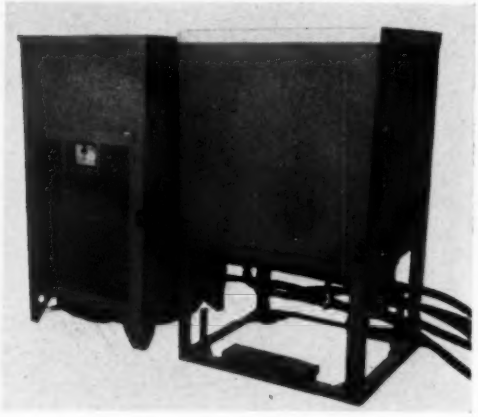


Fig. 12. Stainless steel processing tank and detached water-conditioning unit.

ing is used for fluoroscopy. The tent has no floor and can be folded without the difficulty of eliminating trapped air which was inherent in the World War II model. Where a floor is required, it can be constructed locally. Adequate blowers are used in obtaining forced ventilation through light-proof sleeves. Similar sleeves are used for bringing electrical circuits and plumbing into the tent. Light-tight zippers are provided in each corner of the tent, so that it is possible to fold any one or all of the walls up onto the tent roof. This feature is especially useful when the tent is used for both fluoroscopy and radiography, and when it is necessary to move litter patients into the tent. The walls can be folded out of the way for radiographic use, and quickly unfolded and zipped together for fluoroscopy. A zipper opening is also provided for the installation of the cassette pass box. A 3×3-foot curtain maze permits access to the darkroom tent during operation. Rings and

loops are attached to the inner parts of the tent roof and walls for various electrical circuits, which can thus be quickly installed and held out of the way.

(*f*) The film-processing equipment (Fig. 12) consists of a stainless steel processing tank equipped with two stainless steel solution tanks and a water-conditioning unit. The conditioner unit is suitable for outdoor operation and hence may be placed outside the darkroom tent. It operates at full capacity on 110 to 120 volts, 60 cycles, and at 80 per cent of specified capacity on 50 cycles. The equipment may be used with or without a pressurized community water source.

When operating without a community water supply and in an ambient temperature of 100° F., the conditioner will circulate a minimum of 60 gallons of water per hour through the tank, and will reduce the temperature of the developer to 68° F. in less than ninety minutes, starting with solutions and water temperature of 100° F.; or it will increase the temperature of the developer to 68° F. in less than ninety minutes, starting with 45° F.

When operating with a community water supply system and in an ambient temperature of 100° F., the conditioner will circulate a minimum of 60 gallons of water per hour and will take an additional 15 gallons of fresh water per hour from the community system. With the 100° F. ambient temperature and solutions and water at 100° F., the conditioner will reduce the developer temperature to 68° F. in less than one hundred and twenty minutes, or will increase the temperature to 68° F. in the same time, starting with solution and water temperature at 45° F.

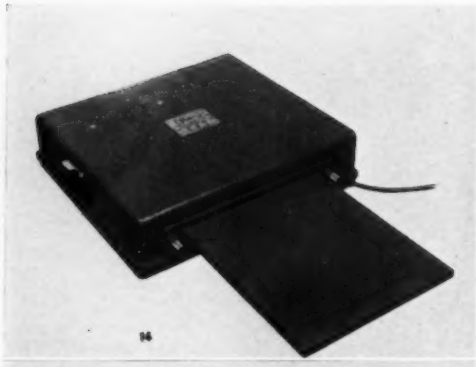
In an ambient temperature of 125° F., and starting with solutions and water at 125° F. with no addition of new water, the conditioner will reduce the developer temperature to 68° F. in less than one hundred and eighty minutes, and after the developer temperature has reached 68° F. it can be maintained in that range with the compressor operating for 80 per cent of the time.

Fig. 13. Folding protective screen.

The conditioner cooler is an hermetically sealed unit using Freon 12, and the condenser is forced air-cooled. The heater is an electric immersion type consuming about 1,500 watts. Thermostats for the heater and cooler are set for a 2° F. differential to reduce cycling.

The tank is divided into four equal sections by three removable baffles so designed as to produce a cascade effect of water flow from one section to another. Two 5-gallon solution tanks are furnished which will fit into any section. The tank is provided with four hoses with quick couplers for interconnection between the tank and the conditioner unit.

For high portability and use with air-



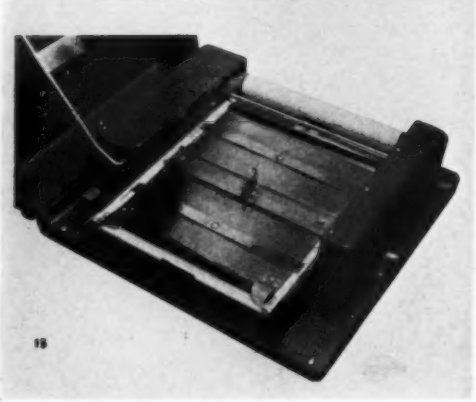


Fig. 14. Land-Polaroid processing unit.
Fig. 15. Land-Polaroid processing unit open for inserting cassette containing exposed film pack.

borne equipment, a special compact lightweight processing unit has been proposed. This unit would provide somewhat limited capacity with the use of 3-gallon instead of 5-gallon insert tanks, and be slightly less efficient with circulating cooled or heated air as the means of conditioning the solutions.

7. The protective screen shown in Figure 13 folds into three sections for easy transportation and has sufficient lead to provide protection against scattered radiation only. This screen measures 3 × 6 feet and is equipped with an 8 × 10-inch lead glass, rubber shock-mounted window.

8. The cassette changer is arranged for the shifting of 14 × 17-inch cassettes. It is adjustable in height and may be operated either magnetically or manually. Since it will be supplied for only the fixed type hospitals, this unit will be similar to the usual commercial models.

9. Several types of stereoscopes have been investigated and two show promise of sufficient portability and usefulness. One consists of prisms cemented together which may be held in front of the eyes to permit stereoscopic viewing of films. Although this type is sufficiently light and small to be carried in a pocket, some radiologists have difficulty in using it. The second type, consisting of a set of simple mirrors installed in a frame which can be held in the hand, permits the stereoscopic image to be obtained more readily. This latter unit packs into a small case and may be easily carried by hand.

10. The radiographic illuminators are of the usual type, employing fluorescent lamps, but are provided with translucent plastic fronts to eliminate breakage of glass.

11. The Land-Polaroid process may be used in forward installations in lieu of, or while preparing, conventional film-processing facilities. This process utilizes special cassettes similar in size to the 8 × 10-inch conventional type, but adapted to hold a special pack of the Land process type. Following exposure of the film pack, the cassette is placed in an electrically operated processing device which withdraws the pack from the cassette, breaks the processing pod, and distributes the chemical over the film. After one minute of development, the processing device is opened and the radiograph is immediately available for use. Figures 14 and 15 show the Land-Polaroid processing unit and cassette. The cassette at present uses paper instead of transparent film. A Land type transparent film, however, is being developed. Even though with paper only one intensifying screen is used, the exposures are not excessive for the technics for which this process is useful. It has the advantage of permitting the radiograph to be viewed within a few minutes after exposure without the necessity of the usual dark-room facilities. For extremities and certain other anatomical

parts, it produces excellent radiographs and permits operation of an x-ray unit under circumstances where more complete equipment could not be made available. While its use is of considerable importance under suitable circumstances, it will probably never replace the conventional radiographic film.

PACKAGING

The emphasis in packaging has been placed on the primary function of providing safe transportation. Provisions for the use of the packing material for furniture have been left to the ingenuity of the individual rather than compromise the effectiveness of the packing arrangement. Reusable plywood packing cases are supplied for equipment intended for fixed type hospital use. Special packaging arrangements have been worked out for mobile field equipment to provide protection under adverse circumstances.

Illustrative of the type of tests which field x-ray equipment is expected to withstand are the rough handling tests given the field x-ray table. The base of this table forms the packing case for the various parts of the table, including a number of fragile elements such as the lead-glass-covered fluoroscopic screen and the Bucky diaphragm. Dropping the packed table unit from a large moving truck on to concrete pavement several times constituted part of the testing. Upon completion of the tests, the unit was assembled and, although not in perfect alignment, it functioned satisfactorily and no parts were found to be broken.

CONCLUSION

Although the development stage of the program has been completed and the line of field x-ray equipment is in production, scrutiny of the units must be continued in order to carry out modifications required to meet future advances in the x-ray equipment art and changing military requirements. Among such advances may be the use of phototiming for general radiography and electronic amplification of the fluoroscopic image.

Sufficient testing has already been carried out to assure that various components of all units so far developed meet the physical and professional requirements. Since the equipment was designed and constructed for a specific purpose, it was not difficult to achieve such features as lightness of weight, ruggedness, durability, and reliable performance. Had modification of available commercial type units been attempted as the means of procuring field x-ray equipment, it would have been more difficult to attain such specific requirements as ease and simplicity of operation, accessibility of components for servicing, and standardization of replacement parts. The specifications are of sufficient detail, and the design of such simplicity, that any component can be manufactured by more than one company provided the required monitoring is carried out to assure complete interchangeability. The problem of supplying replacement parts in the field has thus been greatly simplified by standardization. Although the equipment varies considerably in many respects from commercial units, nothing considered essential for high-quality radiography and fluoroscopy has been sacrificed. The radiologist will, therefore, experience little difficulty in his transition from civilian to military radiology.

ACKNOWLEDGEMENTS: The success of the program has been due to the efforts of many individuals and organizations, and to these our acknowledgements are offered, particularly the engineers and officials of various manufacturing companies for their unstinted efforts and cooperation, and members of Defense Services for the planning and administering of the many projects and for their evaluation of the equipment from a field standpoint. The program could not have advanced without the guidance and advice of the professional consultants who determined the professional characteristics required. All of the many suggestions given the development committee were of considerable help and many found application in this line of field x-ray units.

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SUMARIO

Instalación Militar de Rayos X para Campaña

Las condiciones en que se llevan a cabo las operaciones militares exigen instalaciones roentgenológicas de diseño y características especiales. Destácanse entre las últimas el peso liviano, la solidez, la sencillez y el uso de partes uniformizadas que permitan intercambios y producción en gran escala por diversos fabricantes bajo presión militar de guerra.

En los hospitales fijos, los aparatos combinados para radiografía y roentgenoscopia se parecen mucho a las grandes unidades comerciales, y no requieren más modificaciones que las que faciliten el transporte, el montaje y desmontaje, las reparaciones y la reposición de piezas desgastadas o averiadas.

Los aparatos para hospitales de sangre (o puestos médicos) son mucho más livianos y de diseño más sencillo, pues a veces hay que mudarlos a la carrera y, en algunos casos, a mano. Para lograr esa movilidad, precisa algún sacrificio de función, pero esa clase de equipos permite, sin embargo, ejecutar los procedimientos esenciales de diagnóstico.

También se toman disposiciones para atender a las películas en condiciones de campaña, conservación de las radiografías, cambios de chasis, contemplación estereoscópica y resguardo.

Ofrécense reseñas pormenorizadas de los distintos artículos que comprende la instalación.

EDITORIAL

The Mathematics of Statistics

For most of us, mathematics is a pain in the neck, and we avoid it whenever we can. We hire an expert to figure our tax. We trust the clerk to make the right change. We buy meat weighed on a computing scale and gasoline from a computing pump. We learned algebra in school, but we've forgotten it! What wonder that most of us neither use nor understand the mathematics of statistics, which deals with general tendencies and random differences. We'd be glad to forget this, too, if we'd ever learned it. Or perhaps we wouldn't forget it, for there's a good likelihood that we'd find frequent occasion to use it, which is certainly not true of algebra.

Statistics deal with chances. It attempts to tell, from looking at a few patients, what one could expect in 100 or 10,000—from making a few measurements, what they would be if one hundred times repeated. Chances indicate the number of times one would encounter this or that in a large population. For me chances have no meaning unless there exists in reality, or in my imagination, a large population or a large number of repetitions of the observation or the measurement in question. Ten per cent mortality means that 100 out of 1,000 die. But if a single person, in complete isolation, has the same disease, he either lives or dies, 100 per cent not 10 per cent. Since the physician deals with patients as individuals one at a time, statistical statements must always have a degree of unreality for him. To make them applicable to the real situation, he must in his imagination apply the same logic, arriving at the same advice, for many similar patients in the future. His aim is to end up his career with the largest number of old patients still 100 per cent living and the fewest 100 per cent dead.

The mathematics of statistics has been worked on by some of the finest brains of the last century. The theorems used in standard statistical calculations are an honest part of mathematics—are rigorously proved. This seems a paradox when we consider the uncertainty, or rather the random scattering of the data dealt with. The concept of randomness is actually of the essence. The most frequent blunder that destroys the trustworthiness of statistical evidence is non-random sampling. It is so natural to operate on those patients who are most promising for cure. A high percentage of five-year cures put forward as proving that the operation is a good one may only prove that the surgeon was timid. The statistical conclusion was, in this imaginary instance, actually inserted into the data by the act of the investigator. That he did so innocently does not make the conclusions any more valid. When it is willful, and the stuff put into the sample is gold, we call it "salting."

There are other common blunders. One is to calculate everything in per cent. When the number of patients or measurements is small, the precision of tabular entries of 33 per cent and 67 per cent, *e.g.*, is spurious. If the number of patients is only 30, there is no possibility of 32 per cent or 34 per cent. One case more or one case less jumps the percentage up to 37 per cent or down to 30 per cent. We are lucky, of course, if the man with 30 patients to report *and a slide rule* doesn't tabulate the above as 33.3 per cent. For small numbers, the reporting of the raw numbers, as 10 out of 30, not only gives the ratio, but also indicates the weight or credibility to be given to it. In other words, it carries more meaning with fewer words than when translated into per

cent. It also removes the temptation to average the percentages of several observations, which can be very bad when one percentage is based on 1 case in 10, and another on 20 cases in 100.

We readily grant the engineer his calculus but are supercilious about the statistician's correlation coefficients. We are often heard to say: "Statistics can prove anything!." The engineer uses his calculus to guide his own actions and we merely ride across his bridge. But the statistician in the medical field is presenting calculations on which we expect to base *our* actions. Conscience demands that we examine critically not only the data but also the logic of the work-up of the data. If we have no understanding of the mathematical tools used we are balked of this. Our conscience hurts us and we do what human nature always tends to do—blame it on somebody else—the statistician most naturally.

With a little knowledge of statistics, we readily become critical of the writer who reports a series of cases and claims too much. Less often scolded, but also culpable, is the one who claims too little. I'm not speaking of the one who "leans over backward" to avoid unwarranted conclusions. I do not in fact condone the leaning either forward or backward. The only honest attitude, it seems to me, is bolt upright. What I am referring to here, however, is the failure to reveal all the meaning contained in the reported data through ignorance of the mathematical technics of extracting the full value. There lies the strength of statistical methods, namely, that they are capable of extracting the value from a set of measurements, any one of which is recognized as unreliable.

All of us use some statistical calculations, if only to compute the average—what the statistician calls the arithmetic mean. Most of us who are reporting our observations, and reading other people's, would profit by knowing and using more.

Hundreds of reports of surgical and radiation results in cancer clutter the literature without adding much to our knowledge. Many concern so few patients that no method of analysis could reveal much. Others are vitiated by willful or unconscious selection of patients. Nearly all present their results as percentage of five-year cures. This five-year-cure convention cheats us out of the information contained in two-, three-, and four-year survivals. Life insurance actuaries have well developed technics for squeezing the juice from these smaller oranges, and also for using the patients who are dead or lost track of before the five years are up.

It has been suggested that when clinicians plan to report their cancer cures, they fill out a data sheet for each patient and send them all to a central team of statisticians to be worked up into warrantable conclusions. The investigator could hope at least to achieve increased mental security concerning the results published, and at most a considerable augmentation of the pertinent conclusions that his data will support.

Radioactive isotopes are "counted", not "measured." The counts are random. The capriciousness of the atom is "regularized" by handling them not one at a time, but in groups. Statistics, quite elementary usually, supplies the method. It can also supply the method for "regularizing" the capriciousness of the individual patient. Now isotopes are in the highest fashion, and we may hope that they will lead statistics into better fashion as a mathematical discipline.

We might even amend our high school curricula, and give as much time to statistics as to quadratics. In fact, we could give up quadratics, for medical students and medical practitioners seldom have use for it even if they remember what they have been taught. They do often have use for statistical theory and method, and might well use it often enough to keep their hand in. They need it for understanding whenever they read or write a paper embodying the results of clinical investigations. R. R. NEWELL, M.D.

ANNOUNCEMENTS AND BOOK REVIEWS

SEVENTH INTERNATIONAL CONGRESS OF RADIOLOGY

The preliminary program of the Seventh International Congress of Radiology to be held in Copenhagen, July 19–25, 1953, has been mailed to 12,000 radiologists throughout the world. Any radiologist failing to receive a copy should write to the Congress Office (Øster, Voldgade 10, Copenhagen K, Denmark), stating whether he prefers the English, French, German, or Spanish version.

Briefly the program is as follows:

General Meetings

1. Potential Developments in Radiology
2. Contrast Media in Diagnosis and Risks Associated Therewith
3. Radioresistance
4. Protection against Ionizing Radiations
5. Uniformity in Therapeutic Cancer Statistics

Section Symposia

Diagnosis
1. Angiocardiography
2. Tumors of the Lung
3. Osteochondrosis of the Spine
4. Tomography

Therapy
1. Radioactive Isotopes in Medical Therapy
2. Present Status of Radiotherapy in Benign Diseases
3. The Radiation Syndrome
4. Cancer of the Cervix Uteri

Biology
1. Chemotherapy of Cancer
2. Isotopes in Biology
3. Intracellular Radiation Action
4. Pathogenesis of Leukemia

Physics
1. Recent Advances in the Diagnostic Applications of the Fluorescent Screen
2. Moving Field Therapy
3. Integral Dose

Technology
1. Diagnosis with High-Voltage Rays
2. The Photo-electric Timing of X-ray Exposures
3. Rapid Serial Angiography
4. High-voltage Particle Accelerators

Potential members of the Congress are urged to enroll as early as possible. Applications for hotel accommodation should be sent on Form B to the Congress Office at the time of enrollment.

Those proffering papers are requested to enclose three copies of their abstracts, which may be submitted in English, French, or German (one language only).

Members bringing cars are advised to indicate this on enrollment.

AMERICAN ROENTGEN RAY SOCIETY

At the meeting of the American Roentgen Ray Society in Houston, Texas, September 23–26, Dr. Charles L. Martin succeeded to the Presidency. Officers elected for the forthcoming year are Dr. Harry M. Weber, Rochester, Minn., President-Elect; Dr. Frederick O. Coe, Washington, D. C., First Vice-President; Dr. Lester W. Paul, Madison, Wis., Second Vice-President; Dr. Wendell G. Scott, St. Louis, Mo., Treasurer; Dr. Barton R. Young, Philadelphia, Penna., Secretary.

KANSAS RADIOLOGICAL MEETING

The Kansas Radiological Society and the Radiological Society of Greater Kansas City will hold jointly their annual three-day meeting at the University of Kansas School of Medicine, Feb. 16–18, 1953. Guest speakers on the occasion will be: Isadore Lampe, M.D., University of Michigan; Edward B. D. Neuhauser, M.D., Children's Hospital, Boston, Mass.; Simeon T. Cantril, M.D., Tumor Institute of Swedish Hospital, Seattle, Wash.; David Pugh, M.D., Mayo Clinic; I. Meschan, M.D., University of Arkansas School of Medicine.

MINNESOTA RADIOLOGICAL SOCIETY

The following new officers were elected by the Minnesota Radiological Society at a recent meeting: President, Dr. Malcolm B. Hanson of Minneapolis; Vice-President, Dr. C. Allen Good, Mayo Clinic, Rochester; Secretary-Treasurer, Dr. John R. Hodgson, Mayo Clinic, Rochester.

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY

The newly elected officers of the Northeastern New York Radiological Society are: Dr. Joseph Rosenstein, President; Dr. I. J. Murnane, Vice-President; Dr. John F. Roach, Albany Hospital, Albany, Secretary-Treasurer. The Society meets in the Capital area on the second Wednesday of October, November, March, and April. An annual meeting will be held in May or June 1953.

Letter to the Editor

PROTECTION OF THE EMBRYO AGAINST RADIATION HAZARDS

To the Editor of Radiology

DEAR SIR:

In reply to the comment by Dr. George W. Henry and to the editorial note by R. H. C.,[1]

[1] Letter to the Editor. Radiation Hazards from Diagnostic Studies. Radiology 59: 256, August 1952. Editorial Note, pp. 256–257.

on our paper, "Radiation Hazards to the Embryo and Fetus,"[2] we wish to state the following:

1. Dr. Henry writes that our "findings with mice graphically illustrate the caution radiologists must consider." He rightly states that "it is an error to assume that the 'dose-effect' may be directly transposed from animals to man," and we agree that "the amount of radiation required for damage in the latter is still unknown." We would add, however, that, in view of this ignorance, it seems a wise precaution to try, whenever possible, to stay below the dose level proved hazardous by extensive animal experiments. There are at least some biological grounds, for example, the number of chromosomes, for guessing that the human embryo may be at least as radiosensitive as the mouse embryo.

2. Both Dr. Henry and R. H. C. imply that 25 r would not ordinarily be received by the patient in competent diagnostic practice. Dr. Henry cites his own radiation factors in support of this and R. H. C. lists four "bad judgments" which would have to be combined to allow a dose of 25 r. Nowhere in our paper did we claim any experience as to what proportion of the users of fluoroscopic equipment (not all of them radiologists) are considered to have "poor or insufficient training" or to employ "poor technical methods." We simply stated that "25 r to the embryo falls within the range used in fluoroscopy." A paper by Sonnenblick, *et al.*, was cited by us as one example of medical publications that support this statement. We do not understand why R. H. C. should claim that, in doing this, we have "stepped beyond" our "knowledge and experience."

Dr. Henry's emphasis on the low doses received at a central depth of the pelvis in the course of taking x-ray *films*, and his remark about cosmic rays, are unfortunate in view of the fact that we cited only fluoroscope data.

3. Dr. Henry apparently sees no possible course of action other than, on the one hand, completely denying women of child-bearing age "the use of necessary radiographic studies" or, on the other, using the conventional precautions during a known pregnancy. R. H. C. ends his note with the general statement that "the crux of the matter still lies with the education and experience of the user of ionizing radiations." Each author thus misses or ignores the main point of our paper, which is to recommend a *new* precaution which involves *additional* education. This recommendation is that, since critical periods for the majority of gross abnormalities occur at a time when pregnancy may still be unsuspected, hazardous irradiation should, whenever possible, be restricted to the two weeks following the last menstrual period, to preclude the possibility of fertilization having taken place. It is this suggestion which we should like radiologists to consider and discuss.

LIANE B. RUSSELL
W. L. RUSSELL
Biology Division
Oak Ridge National Laboratory

[2] Russell, L. B., and Russell, W. L.: Radiation Hazards to the Embryo and Fetus. Radiology 58: 369–377, March 1952.

Books Received

Books received are acknowledged under this heading and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

RADIOLOGIC DIAGNOSIS OF THE LOWER URINARY TRACT. By DONALD E. BEARD, M.D., Assistant in Urology, Emory University School of Medicine; Visiting Urologist, Grady Memorial Hospital, Atlanta, Georgia; WILLIAM E. GOODYEAR, M.D., Assistant in Urology, Emory University School of Medicine; Visiting Urologist, Grady Memorial Hospital, Atlanta, Georgia; H. STEPHEN WEENS, M.D., Professor and Chairman, Department of Radiology, Emory University School of Medicine; Radiologist, Grady Memorial Hospital and Emory University Hospital, Atlanta, Georgia. A volume of 144 pages with 280 illustrations. Published by Charles C Thomas, Springfield, Ill., 1952. Price $6.50.

POST-GRADUATE LECTURES ON ORTHOPEDIC DIAGNOSIS AND INDICATIONS. By ARTHUR STEINDLER, M.D., F.A.C.S., Professor of Orthopedic Surgery, State University of Iowa, Iowa City, Iowa. Volume IV. Section A: Arthritis and Diseases of Muscles, Bursae, Tendons, and Fasciae. Section B: Deficiency and Degenerative Diseases of the Locomotor System. A volume of 312 pages, with 276 illustrations. Published by Charles C Thomas, Springfield, Ill., 1952. Price $9.75.

SYMPOSIUM ON PHYSIOLOGICAL EFFECTS OF RADIATION AT THE CELLULAR LEVEL. Sponsored by The Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, April 12–13, 1951. A monograph of 233 pages, with 10 tables and 38 illustrations. Reprinted from Journal of Cellular and Comparative Physiology, Vol. 39, Supplement 2, July 1952. Published by The Wistar Institute of Anatomy and Biology, Philadelphia, 1952. Available without cost to scientific investigators in the field of Radiation Biology.

LEHRBUCH DER RÖNTGENOLOGISCHEN DIFFERENTIALDIAGNOSTIK. By WERNER TESCHENDORF, Köln, Germany. Third Edition. BAND I. ERKRAN-

KUNGEN DER BRUSTORGANE. A volume of 954 pages, with 1030 illustrations. Published by Georg Thieme, Stuttgart, 1952. Agents for U.S.A., Grune & Stratton, Inc., New York, N. Y. Price DM 129.—

GYNÄKOLOGISCHE STRAHLENTHERAPIE. INDIKATIONSSTELLUNG, METHODIK UND ÄRZTLICHE BETREUUNG. By DR. MED. RICHARD KURT KEPP, Apl. Professor für Geburtshilfe und Frauenheilkunde an der Universität Göttingen, with a foreword by PROF. DR. HEINRICH MARTIUS, Direktor der Universitäts-Frauenklinik Göttingen. A volume of 232 pages, with 64 illustrations. Published by Georg Thieme, Stuttgart, 1952. Agents for U. S. A., Grune and Stratton, Inc., New York, N. Y. Price DM 26.—

GRUNDLAGEN DER RÖNTGENDIAGNOSTIK UND RÖNTGENTHERAPIE. By PROF. DR. G. SCHULTE, Recklinghausen, AND Dr. F. KUHLMANN, Essen. Third Edition. A volume of 298 pages with 331 illustrations. Published by Georg Thieme, Stuttgart, 1952. Agents for U. S. A., Grune & Stratton, Inc., New York, N. Y. Price DM 29.70.

LEHRBUCH DER RÖNTGENDIAGNOSTIK. By H. R. SCHINZ, W. E. BAENSCH, E. FRIEDL, E. UEHLINGER, with contributions by E. BRANDENBERGER, A. BRUNNER, U. COCCHI, N. P. G. EDLING, J. EGGERT, F. K. FISCHER, M. HOLZMANN, H. KRAYENBÜHL, Å. LINDBOM, E. LINDGREN, G. A. PREISS, S. WELIN, AND A. ZUPPINGER. Fifth Edition, completely revised. 8. Lieferung: Innere Organe. A volume of 454 pages, with 559 illustrations, plus the title page, contents, and subject index to Lieferungen 5–8, and the author index of the entire work. Published by Georg Thieme, Stuttgart, 1952. Agents for U. S. A., Grune and Stratton, Inc., New York, N. Y. Price DM. 96.—

ANGIOQUIMOGRAFIA. ENSAIO DA SUA APLICACAO AO ESTUDO DA HEMODINÂMICA. By DR. AYRES DE SOUSA. Médico-Chefe de Serviço de Radiologia dos Hosp. Civis. A monograph of 250 pages, with 173 illustrations. Published by Livraria Portugalia, Lisboa, 1951.

Book Reviews

ROENTGENOLOGY IN OBSTETRICS AND GYNECOLOGY. WILLIAM SNOW, M.D., Chief Radiologist, Veterans Hospital and Consulting Radiologist, Willis-Knighton Memorial Hospital and Clinic, Shreveport, La.; formerly Director of Roentgenology, the Harlem Hospital and the Bronx Hospital, New York, N. Y. Second edition. A volume of 364 pages with 305 illustrations. Published by Charles C Thomas, Springfield, Ill., 1952. Price $10.50.

Radiographic investigation of obstetric and gynecologic problems has in recent years assumed great importance. Dr. Snow published one of the first authoritative volumes in this field, *Clinical Roentgenology of Pregnancy*, in 1942. The Second Edition of that work appears under the more comprehensive title given above and describes many refinements in this application of radiology.

The chapter on pelvimetry presents the most popular technics and discusses their advantages and disadvantages. The mechanisms and factors that influence position, engagement, and delivery are evaluated in such a way as to give the roentgenologist a more thorough insight into the problems that confront the obstetrician. The sections on the diagnosis of fetal malformations and soft-tissue abnormalities of pregnancy are among the most valuable portions of the book. Recent studies on the evaluation of gynecologic problems are presented, with excellent reproductions, indicating the importance of this type of procedure to all concerned. Thorough bibliographies are included where necessary.

In format, this second edition differs markedly from the original work. It provides, also, more pleasurable and informative reading.

PHYSICAL FOUNDATIONS OF RADIOLOGY. BY OTTO GLASSER, Professor of Biophysics, Head of Department of Biophysics, Cleveland Clinic Foundation, Cleveland, Ohio; EDITH H. QUIMBY, Associate Professor of Radiology (Physics), College of Physicians and Surgeons, Columbia University, New York; LAURISTON S. TAYLOR, Chief, Atomic and Radiation Physics Division, National Bureau of Standards, Washington, D. C.; and J. L. WEATHERWAX, American Oncologic Hospital and Graduate School of Medicine, University of Pennsylvania, Philadelphia. Second Edition, revised and enlarged. A volume of 582 pages, with 58 tables, 112 figures, and an Appendix including 11 Roentgen Ray Depth Dose Tables. Published by Paul B. Hoeber, Inc. (Medical Book Department of Harper & Brothers), New York, N. Y. Price $6.50.

The excellence of this book has already been proved by the fact that the earlier edition underwent eight printings. The authors have revised the text to incorporate all the important portions of the First Edition and have added approximately 150 pages to bring the work completely up to date. A great amount of progress was made in Radiology in the eight years between the two editions and this is covered in the Second Edition by various revisions of the old text and by the addition of two new chapters, on radioactive isotopes, and high energy accelerators and supervoltage generators, all of which are becoming more and more important to the radiol-

ogist in his daily work. Many new tables are included, especially on radium dosage and on protection. The chapters on measurement of x-ray quality and quantity have also been expanded.

Approximately seventy new illustrations have been incorporated. Many of them present new information, while a few are replacements intended to convey information more clearly and quickly than before.

The roentgen-ray depth dose tables in the Appendix are more extensive than they were previously, ranging from h.v.l. 1.0 mm. Al to 8.0 mm. Cu. Also, determinations of depth dose of twice the number of surface areas are given, making possible direct reading without resort to interpolation calculations.

The reader will find that in comparison with the First Edition, which was already excellent, the text is much more thorough in its coverage and more clarified in its presentation. This book has become the radiologist's Bible and the Second Edition will serve to increase its usefulness and popularity.

MALIGNANT DISEASE AND ITS TREATMENT BY RADIUM. By SIR STANFORD CADE, K.B.E., CB., F.R.C.S., M.R.C.P., F.F.R. (Hon.), Surgeon, Westminster Hospital; Consulting Surgeon, Mount Vernon Hospital and Radium Institute; Lecturer in Surgery, Westminster Medical School and formerly Examiner in Surgery University of London; Member of the Council, late Hunterian Professor, Arris and Gale Lecturer and member of the Court of Examiners, Royal College of Surgeons of England; Hon. Member of the American Radium Society; Consultant in Surgery to the Royal Air Force. With a foreword by SIR ERNEST ROCK CARLING, F.R.C.P., F.R.C.S., F.F.R., Consulting Surgeon and Vice-President Westminster Hospital. Second Edition, Volume IV. A volume of 544 pages, with 785 figures, many in color, and 215 tables. Published by John Wright & Sons, Ltd., Bristol, England, and the Williams & Wilkins Co., Baltimore, 1952. Price $12.50.

This fourth volume of Cade's ably written book on the natural history, diagnosis, pathology, and methods of treatment of cancer covers malignant tumors of the skin, kidney, testis, prostate, bones, soft tissue, lymphoid tissue, and intracranial structures, as well as the leukemias. Again the wide knowledge of the author is demonstrated by the excellent coverage of all phases of his subject. In the preface, he states that successful treatment of malignant diseases depends on three factors: "a sound knowledge of the disease; a wise selection of the method of treatment; and accurate and skillful technique," and again that "choice of the best method of treatment requires complete freedom from bias for any particular form of treatment. . . ."

This volume, as well as the three preceding it, is a must for the physician who is engaged in the treatment of malignant growth. It should do much toward accomplishing the author's ideal.

The book is well bound and has an attractive format. An adequate index is included, covering all four volumes. The illustrations are profuse and of excellent quality.

In Memoriam

M. LOWRY ALLEN, M.D.

1893–1952

We record with sorrow the passing of Moore Lowry Allen on Aug. 2, 1952. For many years he had been handicapped by a cardiac ailment, but the end came suddenly and without premonitory warning, while he was at work in his office. With his death, not only Utah but national Radiology has lost a staunch protagonist whose place will be difficult to fill.

Lowry Allen was born in Mount Pleasant, Utah, April 3, 1893, the only son of Dr. Samuel H. and Ida May Lowry Allen. He received his preliminary scholastic training in Provo and Salt Lake City, Utah, attended the University of Maryland, and was graduated from the University of Pennsylvania

with honors in 1924. Following internship at the Polyclinic and Medico-Chirurgical and Children's Hospitals of Philadelphia, he engaged in private practice in Winter Quarters and Clear Creek, Utah, from 1927 until 1931, when he received a fellowship in Radiology at the Hospital of the University of Pennsylvania. Upon completion of that training, in 1933, he became Radiologist of the Protestant Episcopal Hospital in Philadelphia and Associate in Radiology on the teaching faculty of the University of Pennsylvania. In 1939 he resigned these appointments to open an office for private practice in Salt Lake City.

When the University of Utah established a four-year course in the Faculty of Medicine, Dr. Allen was appointed the first Professor of Radiology, a position from which he retired in 1946. At various times he was Radiologist to the Utah Valley Hospital, Provo, the Geneva Steel Co., Geneva, Utah, and the Regional Office of the U. S. Veterans' Administration in Salt Lake City. He was, as well, Consulting Radiologist to the Latter Day Saints Hospital, Salt Lake City, and Idaho Falls, Idaho, and the State Mental Hospital, Provo, Utah. During World War I he served as an enlistee in the Naval Hospital Corps, and during World War II as Radiologist of the Medical Advisory Draft Board for Utah.

A member of the Church of Jesus Christ of Latter Day Saints, Dr. Allen was a missionary for the Church in Germany and in the United States, from 1913 until 1916.

Dr. Allen's society memberships were legion. He was a Diplomate of the American Board of Radiology, Fellow of the American College of Radiology, and member of the Radiological Society of North America, American Roentgen Ray Society, Rocky Mountain Radiological Society, and the Utah State Radiological Society, of which he was a past-president. He was a member of the American Medical Association, Utah State Medical Association, and Salt Lake County Medical Society. He was Delegate from Utah to the Association of American Physicians and Surgeons and President of the Utah Alumni Group of the University of Pennsylvania. He was also a member of the Utah Chapter, Sons of the American Revolution, of the University Club, and the Ensign Club, Salt Lake City, serving the latter as president in 1949–50.

A physician of positive and engaging personality, Dr. Allen was held in the highest esteem by the profession in Utah. He rarely missed a meeting of either the county or state medical organizations, and his counsel and advice, always based in deeply rooted conviction, received close attention and careful consideration. He was an ardent supporter of the private practice of medicine, particularly radiology. In his passing, our specialty has lost a devoted advocate who will be sorely missed.

Dr. Allen is survived by his wife, the former Emily V. Stasinski of Philadelphia, and by four children, twin sons by a former marriage, Dr. Samuel M. Allen and Bradford H. Allen, and Myra E. and M. Lowry, Jr.

ANGUS K. WILSON, M.D.

RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES

Editor's Note: Secretaries of state and local radiological societies are requested to co-operate in keeping this section up-to-date by notifying the editor promptly of changes in officers and meeting dates.

RADIOLOGICAL SOCIETY OF NORTH AMERICA. *Secretary-Treasurer*, Donald S. Childs, M.D., 713 E. Genesee St., Syracuse 2, N. Y.

AMERICAN RADIUM SOCIETY. *Secretary*, John E. Wirth, M.D., 635 Herkimer St., Pasadena 1, Calif.

AMERICAN ROENTGEN RAY SOCIETY. *Secretary*, Barton R. Young, M.D., Germantown Hospital, Philadelphia 44, Penna.

AMERICAN COLLEGE OF RADIOLOGY. *Exec. Secretary*, William C. Stronach, 20 N. Wacker Dr., Chicago 6.

SECTION ON RADIOLOGY, A. M. A. *Secretary*, Paul C. Hodges, M.D., 950 East 59th St., Chicago 37.

Alabama

ALABAMA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. A. Meadows, Jr., M.D., Medical Arts Bldg., Birmingham 5.

Arizona

ARIZONA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. Lee Foster, M.D., 15 East Monroe, Phoenix. Annual meeting with State Medical Association; interim meeting in December.

Arkansas

ARKANSAS RADIOLOGICAL SOCIETY. *Secretary*, Fred Hames, M.D., Pine Bluff. Meets every three months and at meeting of State Medical Society.

California

CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY. *Secretary*, Calvin L. Stewart, M.D., 2330 First Ave., San Diego.

EAST BAY ROENTGEN SOCIETY. *Secretary*, Dan Tucker, M.D., 434 30th St., Oakland 9. Meets monthly, first Thursday, at Peralta Hospital.

LOS ANGELES RADIOLOGICAL SOCIETY. *Secretary*, John B. Hamilton, M.D., 210 N. Central Ave., Glendale 3. Meets monthly, second Wednesday, Los Angeles County Medical Association Bldg.

NORTHERN CALIFORNIA RADIOLOGICAL SOCIETY. *Secretary*, Richard C. Ripple, M.D., 1215 28th St., Sacramento 16. Meets at dinner last Monday of September, November, January, March, and May.

PACIFIC ROENTGEN SOCIETY. *Secretary*, L. Henry Garland, M.D., 450 Sutter St., San Francisco 8. Meets annually at time of California State Medical Association convention.

SAN DIEGO RADIOLOGICAL SOCIETY. *Secretary*, Rex Uncapher, M.D., 7720 Girard Ave., La Jolla. Meets first Wednesday of each month.

SAN FRANCISCO RADIOLOGICAL SOCIETY. *Secretary*, I. J. Miller, M.D., 2680 Ocean Ave., San Francisco 27. Meets quarterly, at the University Club.

SOUTH BAY RADIOLOGICAL SOCIETY. *Secretary*, Ford Shepherd, M.D., 526 Soquel Ave., Santa Cruz. Meets monthly, second Wednesday.

X-RAY STUDY CLUB OF SAN FRANCISCO. *Secretary*, Charles E. Duisenberg, M.D., Palo Alto Clinic, 300 Homer Ave., Palo Alto. Meets third Thursday at 7:45, January to June at Stanford University Hospital, July to December at San Francisco Hospital.

Colorado

COLORADO RADIOLOGICAL SOCIETY. *Secretary*, Wm. S. Curtis, M.D., 304 Republic Bldg., Denver. Meets monthly, third Friday, at University of Colorado Medical Center or Denver Athletic Club.

Connecticut

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary-Treasurer*, William A. Goodrich, M.D., 85 Jefferson St., Hartford 14. Meets bimonthly, second Wednesday.

CONNECTICUT VALLEY RADIOLOGICAL SOCIETY. *Secretary*, B. Bruce Alicandri, M.D., 20 Maple St., Springfield, Mass. Meets second Friday of October and April.

District of Columbia

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY. *Secretary*, U. V. Wilcox, M.D., 915 19th St., N.W., Washington 6. Meets third Thursday, January, March, May, and October, at 8:00 P.M., in Medical Society Library.

Florida

FLORIDA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, A. Judson Graves, M.D., 2002 Park St., Jacksonville. Meets in April and in November.

GREATER MIAMI RADIOLOGICAL SOCIETY. *Secretary*, Maurice Greenfield, M.D., Ingraham Bldg., Miami. Meets monthly, third Wednesday, 8:00 P.M., Veterans Administration Bldg., Miami.

Georgia

ATLANTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Albert A. Rayle, Jr., M.D., 478 Peachtree St. Meets second Friday, September to May.

GEORGIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Robert M. Tankesley, M.D., 218 Doctors Bldg., Atlanta. Meets in November and at the annual meeting of the State Medical Association.

RICHMOND COUNTY RADIOLOGICAL SOCIETY. *Secretary*, Wm. F. Hamilton, Jr., M.D., University Hospital. Augusta.

Hawaii

RADIOLOGICAL SOCIETY OF HAWAII. *Secretary*, Col. Alexander O. Haff, Tripler Army Hospital, Honolulu. Meets monthly on the third Friday, at Tripler Army Hospital.

Illinois

CHICAGO ROENTGEN SOCIETY. *Secretary*, Elbert K. Lewis, M.D., 6337 S. Harvard Ave., Chicago 21. Meets at the University Club, second Thursday of October, November, January, February, March, and April at 8:00 P.M.

ILLINOIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Stephen L. Casper, M.D., Physicians and Surgeons Clinic, Quincy.

ILLINOIS STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, George E. Irwin, Jr., M.D., 427 N. Main St., Bloomington.

Indiana

INDIANA ROENTGEN SOCIETY. *Secretary-Treasurer*, John A. Robb, M.D., 23 East Ohio St., Indianapolis. Annual meeting in May.

Iowa

IOWA X-RAY CLUB. *Secretary*, James McMillen, M.D., 1104 Bankers Trust Bldg., Des Moines. Meets during annual session of State Medical Society, and holds a scientific session in the Fall.

Kansas

KANSAS RADIOLOGICAL SOCIETY. *Secretary*, Willis L. Beller, M.D., 700 Kansas Ave., Topeka. Meets in the Spring with the State Medical Society and in the Winter on call.

Kentucky

KENTUCKY RADIOLOGICAL SOCIETY. *Secretary*, Everett L. Pirkey, M.D., Louisville General Hospital. Meets monthly, second Friday, at Seelbach Hotel, Louisville.

Louisiana

ORLEANS PARISH RADIOLOGICAL SOCIETY. *Secretary*, Joseph V. Schlosser, M.D., Charity Hospital of Louisiana, New Orleans 13. Meets second Tuesday of each month.

SHREVEPORT RADIOLOGICAL CLUB. *Secretary*, W. R. Harwell, M.D., 608 Travis St. Meets monthly September to May, third Wednesday.

Maine

MAINE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Hugh Allan Smith, M.D., Eastern Maine General Hospital, Bangor. Meets three times a year—Spring, Summer, and Fall.

Maryland

BALTIMORE CITY MEDICAL SOCIETY, RADIOLOGICAL SECTION. *Secretary-Treasurer*, H. Leonard Warres, 2337 Eutaw Place, Baltimore 17. Meets third Tuesday, September to May.

Michigan

DETROIT X-RAY AND RADIUM SOCIETY. *Secretary*, James C. Cook, M.D., Harper Hospital, Detroit 1. Meets first Thursday, October to May, at Wayne County Medical Society club rooms.

Minnesota

MINNESOTA RADIOLOGICAL SOCIETY. *Secretary*, John R. Hodgson, M.D., The Mayo Clinic, Rochester. Meets in Spring and Fall.

Mississippi

MISSISSIPPI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John W. Evans, M.D., 621 High St., Jackson 2, Miss. Meets monthly, third Tuesday, at 6:30 P.M., at the Rotisserie Restaurant, Jackson.

Missouri

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY. *Secretary*, Sidney Rubin, M.D., 410 Professional Bldg., Kansas City, Mo. Meets last Friday of each month.

ST. LOUIS SOCIETY OF RADIOLOGISTS. *Secretary*, Francis O. Trotter, Jr., M.D., 634 North Grand Blvd., St. Louis 3. Meets on fourth Wednesday, October to May.

Nebraska

NEBRASKA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, James F. Kelly, M.D., 1816 Medical Arts Bldg., Omaha. Meets fourth Thursday of each month at 6 P.M. in Omaha or Lincoln.

New England

NEW ENGLAND ROENTGEN RAY SOCIETY. *Secretary*, Stanley M. Wyman, M.D., Massachusetts General Hospital, Boston 14. Meets monthly on third Friday, at the Harvard Club, Boston.

New Hampshire

NEW HAMPSHIRE ROENTGEN SOCIETY. *Secretary*, Albert C. Johnston, M.D., 127 Washington St., Keene.

New Jersey

RADIOLOGICAL SOCIETY OF NEW JERSEY. *Secretary*, Nicholas G. Demy, M.D., 912 Prospect Ave., Plainfield. Meets at Atlantic City at time of State Medical Society and midwinter in Elizabeth.

New York

BUFFALO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Mario C. Gian, M.D., 610 Niagara St., Buffalo 1. Meets second Monday, October to May.

CENTRAL NEW YORK ROENTGEN SOCIETY. *Secretary*, Dwight V. Needham, M.D., 608 E. Genesee St., Syracuse 2. Meets in January, May, October.

KINGS COUNTY RADIOLOGICAL SOCIETY. *Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meets fourth Thursday, October to April (except December), at 8:45 P.M., Kings County Medical Bldg.

NASSAU RADIOLOGICAL SOCIETY. *Secretary*, Joseph J. La Vine, M.D , 259 North Grand Avenue, Baldwin, N.Y. Meets second Tuesday, February, April, June, October, and December.

NEW YORK ROENTGEN SOCIETY. *Secretary*, Harold W. Jacox, 622 W. 168th St., New York 32.

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John F. Roach, M.D., Albany Hospital, Albany. Meets in the capital area second Wednesday, October, November, March, and April. Annual meeting in May or June.

ROCHESTER ROENTGEN-RAY SOCIETY. *Secretary-Treasurer*, Robert J. Bloor, M.D., 260 Crittenden Blvd. Meets at Strong Memorial Hospital, last Monday of each month, September through May.

WESTCHESTER RADIOLOGICAL SOCIETY. *Secretary*, Walter J. Brown, M.D., Northern Westchester Hospital, Mount Kisco, N. Y. Meets third Tuesday of January and October and at other times as announced.

North Carolina

RADIOLOGICAL SOCIETY OF NORTH CAROLINA. *Secretary*, Waldemar C. A. Sternbergh, 1400 Scott Ave., Charlotte 2. Meets in April and October.

North Dakota

NORTH DAKOTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, H. Milton Berg, M.D., Quain & Ramstad Clinic, Bismarck. Meets in the Spring with State Medical Association and in the Fall or Winter on call.

Ohio

OHIO STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Willis S. Peck, M.D., 1838 Parkwood Ave., Toledo 2. Meets with State Medical Association.

CENTRAL OHIO RADIOLOGICAL SOCIETY. *Secretary*, Frank A. Riebel, M.D., 15 W. Goodale St., Columbus. Meets second Thursday, October, December, February, April, and June, 6:30 P.M., Columbus Athletic Club, Columbus.

CLEVELAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Mortimer Lubert, M.D., Heights Medical Center Bldg., Cleveland Heights 6. Meets at 6:45 P.M. on fourth Monday, October to April, inclusive.

GREATER CINCINNATI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Harry K. Hines, M.D., 2508 Auburn Ave., Cincinnati 19. Meets first Monday of each month, September to June, at Cincinnati General Hospital.

MIAMI VALLEY RADIOLOGICAL SOCIETY. *Secretary*, W. S. Koller, M.D., 60 Wyoming St., Dayton. Meets monthly, second Friday.

Oklahoma

OKLAHOMA STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John R. Danstrom, M.D., Medical Arts Bldg., Oklahoma City.

Oregon

OREGON RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Richard Raines, M.D., Medical-Dental Bldg., Portland 5. Meets monthly, second Wednesday, October to June, at 8:00 P.M., University Club.

Pacific Northwest

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Sydney J. Hawley, M.D., 1320 Madison St., Seattle 4. Meets annually in May.

Pennsylvania

PENNSYLVANIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, James M. Converse, M.D., 416 Pine St., Williamsport 8. Meets annually.

PHILADELPHIA ROENTGEN RAY SOCIETY. *Secretary*, George P. Keefer, M.D., American Oncologic Hospital, Philadelphia 4. Meets first Thursday of each month at 5:00 P.M., from October to May, in Thompson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY. *Secretary-Treasurer*, Donald H. Rice, M.D., West Penn Hospital, Pittsburgh 24. Meets monthly, second Wednesday, at 6:30 P.M., October to May, at Webster Hall.

Rocky Mountain States

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Maurice D. Frazer, M.D., 1037 Stuart Bldg., Lincoln, Nebr.

South Carolina

SOUTH CAROLINA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*. Henry E. Plenge, M.D., Spartanburg General Hospital, Spartanburg. Meets with State Medical Association in May.

South Dakota

RADIOLOGICAL SOCIETY OF SOUTH DAKOTA. *Secretary-Treasurer*, Donald J. Peik, M.D., 303 S. Minnesota Ave., Sioux Falls. Meets during annual meeting of State Medical Society.

Tennessee

MEMPHIS ROENTGEN CLUB. *Secretary*, John E. Whiteleather, M.D., 899 Madison Ave. Meets first Monday of each month at John Gaston Hospital.

TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Marsh Frère, M.D., Newell Hospital, Chattanooga 2. Meets annually with State Medical Society in April.

Texas

DALLAS-FORT WORTH ROENTGEN STUDY CLUB. *Secretary*, Claude Williams, M.D., Fort Worth. Meets monthly, third Monday, in Dallas odd months, Fort Worth even months.

HOUSTON RADIOLOGICAL SOCIETY. *Secretary*, Frank M. Windrow, M.D., 1205 Hermann Professional Bldg.

SAN ANTONIO-MILITARY RADIOLOGICAL SOCIETY. *Secretary*, Hugo F. Elmendorf, Jr., M.D., 730 Medical Arts Building, San Antonio 5, Texas. Meets at Brook Army Medical Center, the first Monday of each month.

TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. P. O'Bannon, M.D., 650 Fifth Ave., Fort Worth. Next meeting Jan. 23–24, 1953, San Antonio.

Utah

UTAH STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Angus K. Wilson, M.D., 343 S. Main St., Salt Lake City 1. Meets third Wednesday, January, March, May, September, November.

Virginia

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THE HEAD AND NECK

Uses of Nuclear Disintegration in the Diagnosis and Treatment of Brain Tumor. William H. Sweet. New England J. Med. **245**: 875–878, Dec. 6, 1951.

This paper reports several useful findings in the course of radioisotope studies at the Massachusetts General Hospital.

(1) P^{32} has been found to concentrate in brain tumors and to give the greatest differentials between tumor and normal brain in the widest variety of neoplastic types. At twelve to forty-eight hours after injection of the isotope, even the most slowly growing, sparsely cellular and avascular gliomas have shown useful ratios of greater than 5:1, while more cellular or more vascular tumors have shown ratios even exceeding 100:1. As P^{32} decays, it emits only beta particles, which travel but a few millimeters in tissue. Hence the introduction of an appropriately sensitive probe counter into the brain permits one to ascertain by the counting rate when neoplastic tissue is entered and what are its limits. A probe type of Geiger-Müller counter designed by Dr. Charles Robinson for this purpose is described. The use of this instrument in defining tumor boundaries rests on such a firm basis that it now forms an integral part of the surgical treatment of many brain tumors.

(2) Efforts have also been made to assist the preoperative diagnosis and localization of brain tumors by detecting a concentration in them of an isotope emitting gamma rays that could penetrate the skull. The authors have used K^{42}. This isotope, although it concentrates to a much higher degree in most brain tumors than the other gamma emitter used (I^{131} diiodofluorescein), is also taken up by muscle. Unfortunately the medium-sized temporal muscles and the bulkier suboccipital muscles give rise to a curtain of gamma radiation outside the tumors that may lie beneath them. For most tumors lying above the muscles, except for the slow-growing astrocytomas, the method appears useful. The author found a tumor smaller than a cherry in this fashion. The method was especially valuable in patients whose brain tumors compressed the lateral ventricle so much that no air would enter it on attempted ventriculography and in other patients with misleading clinical signs.

(3) A better method for external localization of brain tumors appears to be in the offing. Matter including living tissue has an annoying tendency to scatter gamma rays; hence the neoplastic energy of these rays at the surface of the scalp is considerably blurred. Special radiation occurs when a positron strikes an electron and the two particles are annihilated, giving rise to a pair of 0.51-mev gamma rays, which go off in opposite directions. By means of a coincidence-counting circuit, only those pairs of gamma rays that are not scattered are registered. The beam can be recorded as a much narrower column when the pairs of annihilation gamma rays from positrons are counted than when directional counting under similar circumstances is tried with I^{131}, the radiation of which is similar in intensity to that of the annihilation gamma ray.

(4) An attempt has also been made to utilize the enormous energy developed at nuclear disintegration to destroy unwanted cells. The tendency of certain isotopes to capture slow neutrons and break up, leaving large amounts of energy, was explored, since a beam of slow neutrons can be confined to a portion of the head. When a neutron is slowed down to speeds of the order of 2,200 meters per second, its energy at that velocity is not enough to ionize any atom it happens to meet by knocking off one of its orbital electrons. It reacts with matter chiefly when the nucleus of an atom captures it. The nuclei of living tissues have only a slight tendency to capture slow neutrons. This cannot be disregarded, however, because there are so many of them. Now, it is known that boron has an enormous capture cross section for slow neutrons. The high-energy large alpha particle that appears travels less than 15 microns in tissue, which means that its destructive effect is confined to a tiny zone in the immediate neighborhood of the cell containing the boron atom. The author believes that if one can put 50 micrograms of boron per gram of tissue into a brain tumor, with only 15 micrograms of boron per gram of normal gray matter, the tumor will receive three times as much radiation as the brain. He has tried borax and finds that such levels are readily attainable in tumor without producing significant toxic effects and that differentials between tumor and brain of 3:1 and 28:1 occur in some rapidly growing gliomatous and carcinomatous lesions for a short interval up to the first half-hour after injection. He is not ready to comment on this work.

This whole report is very interesting. It is good to see isotopes put to new medical uses.

Five figures; 3 tables.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

A Pathognomonic Sign of Leakage of Cerebrospinal Fluid into the Subdural Space. A. A. McConnell. Irish J. M. Sc., November 1951, pp. 550–551.

Cerebrospinal fluid cannot be absorbed anywhere except from the subarachnoid space over the convexity of the brain. If the arachnoid membrane be torn, the fluid escapes into the subdural space, where it remains indefinitely. This leakage is common in cases of closed head injuries and is therefore of medicolegal significance. It is seen with particular frequency in patients who are surviving a head injury but not recovering. Such accumulations are pathological and can produce or exaggerate post-traumatic symptoms, such as headache, lack of concentration, impairment of memory, dizziness, irritability, and the defeatist mentality so marked in some patients after head injury.

The author describes a sign which he believes to be pathognomonic of leakage of cerebral spinal fluid into the subdural space. An encephalogram is taken immediately after the replacement of 120 c.c. of cerebrospinal fluid by an equal quantity of air by lumbar puncture. The air will be found to be diffusely distributed in the ventricles and the subarachnoid channels. An encephalogram taken twenty-four hours later will show the bulk of the air accumulated in the subdural space and a fluid level will be demonstrable. Of 19 patients submitted to encephalography, air was seen in the subdural space on the second day in 17, and in all these the characteristic fluid was found at operation.

That leakage of fluid into the subdural space is

fairly common is indicated by a series of 212 cases coming to operation, in which it was found 101 times, while the number of patients with all types of intracranial hemorrhage was 102.

Two roentgenograms.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Roentgenological Skull Measurements and Their Diagnostic Applications. Lewis L. Haas. Am. J. Roentgenol. **67**: 197–209, February 1952.

Roentgenograms of a series of 320 white European adults and a second series of 1,300 racially mixed patients at the University of Illinois Hospitals were studied to determine the normal limits of various skull diameters. In the first group the greatest length of the skull was measured; in the second, the longitudinal, vertical, and transverse diameter measurements were recorded. In the latter group the modulus and cephalic index were also computed.

The greatest length diameter was measured as the distance from the glabella to the opisthocranion. A marked protrusion of the frontal sinus or of the occiput may render this evaluation more difficult. Moderate frontal protrusion is quite common; it was found in 42 per cent of adult males in this series and in 4 per cent of the adult females. The average length in males is greater than in females in all age groups; the average male diameter measures 22.0 cm., the female average is 20.9 cm. Growth ceases in females around the fifteenth year, in males around the twentieth.

The height of the skull was measured from the basion to the vertex. The average adult male height was 15.6 cm.; female, 15.4 cm. Neither sex showed significant increase after the twelfth year.

Roentgenologic measurement of the skull breadth at the upper margin of the squamous suture, or slightly above it at the level of the stephanion, is of limited reliability. This measurement averages 4 to 8 mm. less on the anteroposterior view as compared with the postero-anterior. The enlargement by projection is greater for the breadth than for other diameters and is less uniform because of the more variable location of the greatest breadth. The average male adult skull breadth is 16.8 cm.; average female, 16.5 cm.

The modulus, $(L + H + Br)/3$, is computed as 17.8 for the average 21-year-old male and 17.5 for females of the same age. The skull growth is fastest in the first year of life, slows from the twelfth year on, and usually stops in the female around the eighteenth and in the male around the twenty-first year. The modulus is a better indicator of skull size than the single diameters, since opposite deviations of single diameters frequently, offset each other when the modulus is computed.

The significance of the modulus is shown by the fact that in 6 of the 18 persons in this series with oversized modulus, the length of the skull was within normal limits, and in 3 none of the diameters was above the upper limit. In 7 instances there was an increased length diameter but a normal modulus.

The cephalic index $(Br \times 100/L)$ is rather characteristic of the shape of the skull. It gradually decreases with age, since after the first year breadth increases less from year to year whereas the length increase is more significant. The average cephalic index for males over twenty-one years of age is 79.5; for females, 79.8.

The author discusses over- and undersized skulls and their causes. Among the causes for abnormally large skulls are: disturbances of the pituitary gland; tumors of the sellar region; occlusive hydrocephalus secondary to intracranial tumors, developmental abnormalities, or adhesions; and increased thickness of the cranial bones as in acromegaly, Paget's disease, and fibrous dysplasia. Undersized skulls are due to any pathologic condition causing retardation of development, as cerebral agenesis, dwarfism, craniopharyngioma.

Eighteen roentgenograms; 6 tables.

BERTRAM LEVIN, M.D.
Minneapolis, Minn.

Question of Posttraumatic Cleft Formation of the Skull. F. Usinger. Fortschr. a. d. Geb. d. Röntgenstrahlen **75**: 712–717, December 1951. (In German)

Ordinarily a fracture of the skull heals by bridging with new bone. Under certain conditions, however, the edges of the fracture may become atrophic and a cleft may develop through which part of the brain may herniate. In such a case the edges of the cleft can usually be plainly palpated and the pulsation of the partially protruding brain can be felt. This condition occurs mostly in children, and the most common clinical sign is the occurrence of epileptiform seizures, usually several months after trauma.

Two theories are advanced for the explanation of cleft formation. According to one, a fracture must have occurred first with more or less severe damage to the dura mater and to the brain itself. It is assumed that the scar developing in the brain reaches down to the ventricular system and, through irritation, causes an excessive production of fluid. This in turn increases the intracranial pressure and may force the scar into the fracture gap, thus preventing bony closure. Eventually, as a result of the increased pressure, an atrophy of the edges of the fracture occurs and a more or less wide cleft may develop. According to the second theory, a disturbance in the blood supply of the cranium is caused by the original injury, leading to bone atrophy and producing a phenomenon that resembles Sudek's atrophy.

The author describes the case of a two-and-one-half-year-old child who sustained a skull fracture. No cleft was noticed on the first x-ray examination. Thirteen months later epileptiform seizures occurred and x-ray examination now showed a cleft in the parietal region. An encephalogram revealed a dilatation of the left lateral ventricle. At operation a wide cleft in the bone was found, with extensive scars leading down to the left lateral ventricle. Microscopic section of the soft tissue showed scar tissue of the dura mater; sections of the fracture edges showed normal juvenile bone.

Three roentgenograms.

WM. A. MARSHALL, M.D.
Chicago, Ill.

THE CHEST

Lung Segments and Segmental Pneumonia. Umberto Cocchi. Fortschr. a. d. Geb. d. Röntgenstrahlen **75**: 57–72, (Sonderheft) December 1951. (In German)

The author stresses the importance of differentiation of pneumonia and atelectasis and the specific localiza-

tion of the disease process in relation to the segmental bronchi. He designates the bronchi according to size and distribution as Order 1, stem bronchi; Order 2, lobe bronchi; Order 3, segmental; Order 4, subsegmental division. The international nomenclature established by the Otolaryngologic Congress which met in London in 1949 was followed. The right upper lobe divisions are designated as 1, apical; 2, posterior; 3, anterior. The left upper lobe divisions are 1 and 2, apical posterior, and 3, anterior; the lingular divisions are 4, superior, and 5, inferior. The right middle lobe divisions are 4, lateral; 5, medial. Both lower lobe divisions are designated as 6, apical; 7, cardiac (on right side only); 8, anterobasilar; 9, laterobasilar; 10, posterobasilar. Axillary segments are occasionally present in any of the lobes, but particularly the upper lobe, and may be seen as an independent branch. Several other variations occasionally occur but are of lesser importance.

A single segment is frequently involved by the disease process, more often two or three adjacent segments. Identification is often difficult, if only a portion of one segment is involved. Tomography and bronchography, correlated with the film studies, aid greatly in diagnosis and localization. The author stresses the importance of views in both the postero-anterior and lateral positions. The axillary division is particularly well identified in the lateral view, as it does not reach either the anterior or posterior lung boundary.

In about one-third of the cases a single segment is involved. In the other two-thirds two or more segments, often adjacent. As examples, in the upper lobes 33 per cent of cases were found to involve the posterior segment, 26 per cent the axillary segment, and 19 per cent the anterior segment. The apical segment (22 per cent) seldom shows an isolated process and, if it does, tuberculosis should be suspected. When there is involvement of the right, middle, or left lingular lobe, especially by atelectasis, it may easily be mistaken for an interlobar process or mass lesion. Involvement of the cardial segment may be confused with pleural thickening. The individual basilar segments are sometimes difficult to identify in detail and may be mistaken for interlobar collections, mass lesions, and pleural thickenings.

[Reference is made to RADIOLOGY **59**: 229–237, August 1952, for graphic illustrations of the segmental divisions in the anteroposterior projections, by Irving J. Kane, and to the Editorial in the same issue, page 252, in which Rigler stresses the importance of this type of work. It is of the greatest value where surgical intervention is under consideration, and every radiologist should have accurate knowledge of these segmental divisions.—E.W.S.]

Nineteen roentgenograms; 11 drawings; 1 table.

E. W. SPACKMAN, M.D.
Fort Worth, Texas

Linear Basal Atelectasis Following Therapeutic Phrenic Nerve Interruption. Richard P. Jahn and John K. Olinger. Am. Rev. Tuberc. **65**: 88–92, January 1952.

The characteristic linear basal shadows recognized as being caused by lobular atelectasis were found in 23 out of a total of 293 patients followed by serial roentgenograms after phrenic nerve interruptions for the treatment of tuberculosis. The mechanism by which this lesion occurs is postulated as an interference with normal bronchial drainage and subsequent obstruction of some of the smaller bronchioles. The interference may result from hypoventilation produced by a variety of intra-abdominal conditions as well as by phrenic nerve interruption, but the authors failed to find a single example of "plate-like" atelectasis in a series of cases treated with pneumoperitoneum without phreniclasia, even with a very marked rise of the diaphragm. No conclusions are reached to explain the absence of the atelectatic areas in the latter group of patients. With resumption of diaphragmatic motion, the linear shadows usually disappeared, though occasionally a fine line of density persisted.

Nine roentgenograms.

JOHN H. JUHL, M.D.
Minneapolis, Minn.

A Clinical-Roentgenologic Contribution to "Microlithiasis Alveolaris Pulmonum." W. Lindig. Fortschr. a. d. Geb. d. Röntgenstrahlen **75**: 678–684, December 1951. (In German)

Most pulmonary calcifications are the result of tuberculosis. They consist of calcific deposits within the connective tissue or within the walls of vessels, in other words within the parenchyma of the lungs. In contradistinction to these, a true lithiasis, that is, stone formation within the hollow space of the alveoli, is exceedingly rare.

There is a condition called *microlithiasis alveolaris pulmonum* (Puhr: Virchows Arch. f. path. Anat. **290**: 156, 1933) which is characterized by the presence of numerous microscopic stones within the alveoli of both lungs. The writer found four cases described in the literature, to which he adds one of his own.

The x-ray appearance is characteristic. The upper portions of both lungs show numerous fine pin-point densities which appear to be rather hard, sharply defined, and evenly distributed over the apices and the infraclavicular areas. In places they are confluent and a little larger. Toward the midportion of the lungs they become much denser, and both lower portions are completely cloudy. The cloudiness is an impenetrable, compact density occupying the major part of both lungs and imparts the impression of a grave pulmonary disease. In contradistinction to this picture, the patient usually appears to be very little disabled; his respiratory capacity may be almost normal or at least only slightly impaired.

The autopsy reports in the literature are strikingly similar. The removed lung appears to be hard and solid, like a sandbag. The cut surface, when touched, gives the sensation of sandpaper. On microscopic section, small round bodies were found in about one-fourth or more of all the alveoli, consisting of concentric layers containing deposits of lime salts. In 2 cases almost all of the alveoli were filled with these small bodies, measuring from 0.03 to 0.3 mm. in diameter. An analysis showed the stones to contain 66.5 per cent calcium phosphate, 8.6 per cent calcium carbonate, 1.7 per cent magnesium carbonate.

Not much is known about the etiology of this condition. Some writers think that it represents a true stone formation, while others believe that the concretions are the calcified end-result of previously formed corpora amylacea. The writer seems to favor the latter theory. Corpora amylacea may be formed within the lungs as the result of chronic inflammation or congestion.

The author's patient was a forty-year-old man who had worked in a mine five years earlier for about a year, during which time he had inhaled a great deal of dust. He complained of shortness of breath. The diagnosis was made on the basis of the typical x-ray film and a diagnostic lung puncture which showed small sections of tissue containing alveoli with calcific deposits. The latter appeared to be calcium carbonate. The patient was observed for six years, and was alive at the time of the report. He still complained of shortness of breath but seemed otherwise to be normal. A recent roentgenogram had again shown the typical findings of microlithiasis. The serum calcium was within normal limits.

The author advises against the aspiration of the lungs for diagnostic purposes; in this patient it was followed by a pneumothorax with dangerous shortness of breath.

Three roentgenograms.

WM. A. MARSHALL, M.D.
Chicago, Ill.

The Tuberculous Mother. A Five- to Twenty-Year Follow-up of 149 Women with 401 Full-Term Pregnancies. Jack D. Cohen, Elizabeth A. Patton, and Theodore L. Badger. Am. Rev. Tuberc. **65**: 1–23, January 1952.

The authors present a study of three groups of patients: (1) 56 mothers from a prenatal clinic in whom tuberculosis was found in the course of routine studies, all in a low-income group; (2) 25 former student nurses with tuberculosis discovered on periodic survey; (3) 68 mothers admitted to a hospital for the treatment of tuberculosis.

The anatomic extent and the pathologic pattern of the disease along with the native resistance or susceptibility of the patients were factors of prognostic significance and the specific factors relating to pregnancy did not seem to be potentially dangerous. The mothers with fibrous and fibrocalcific lesions had no difficulty and most of those with minimal exudative lesions arrested a year or more before pregnancy had no reactivation. Patients with cavernous tuberculosis had the worst prognosis, which is to be expected. In the low-income group (1, above) it was felt that the relatively good prognosis was due to the native resistance developed by these patients, who represented the "survival of the fittest."

The authors do not believe that tuberculosis should be an indication for termination of pregnancy. The tuberculous disease should be treated intensively during the pregnancy. Although Streptomycin was not available at the time the present study was initiated, the authors are now using it in doses comparable to those used in the non-pregnant patient. The mother with active tuberculosis should neither nurse nor care for her infant until the infectiousness is gone. It is also recommended that mothers treated for minimal tuberculosis be advised to let two years elapse with their disease in the arrested state before becoming pregnant, with a three-year lapse in those with moderately advanced disease. Those with far advanced disease have such a poor prognosis with or without pregnancy that they should be advised to defer childbearing until it is clear that treatment has established an arrested and stable lesion for at least five years.

Seventeen tables.

JOHN H. JUHL, M.D.
Minneapolis, Minn.

Tuberculosis in Anthracosilicosis. Peter A. Theodos and Burgess Gordon. Am. Rev. Tuberc. **65**: 24–47, January 1952.

Among a total of 750 hard coal miners hospitalized in various stages of anthracosilicosis, the diagnosis of active reinfection type tuberculosis was established in 97 (12.9 per cent) cases. Exposure to silica varied from thirteen to fifty years, and the patients ranged in age from thirty-three to sixty-seven years. The highest incidence of tuberculosis (75 per cent) occurred in the fourth and fifth decades. This represented a marked increase in prevalence of tuberculosis (eight to one) as compared to findings in a group of male industrial workers; in the older groups, the increase was less marked. The diagnosis of tuberculosis was easily made in most cases, a direct sputum smear being positive in 85.6 per cent.

Roentgenographic findings were those of silicosis, which was largely third stage (88 per cent), plus findings due to tuberculosis, which were definite in most cases. The tuberculosis was minimal in 7.2 per cent, moderately advanced in 21.6 per cent, and far advanced in 71.2 per cent. Asymmetry of shadows was not found to be an important criterion in the diagnosis of silicotuberculosis, since of 320 patients with asymmetrical lesions, only 26 per cent were proved to have tuberculosis; the same was true in patients with a tracheal shift, which has been thought to suggest the presence of tuberculosis associated with silicosis.

Prognosis was found to be poor, averaging from two to three years survival with treatment at home and only slightly longer with hospital care. There is some relationship between the severity of silicosis and life expectancy, with a better prognosis in patients with nodular than with conglomerate disease associated with tuberculosis.

Treatment is difficult because of the impairment of pulmonary function by silicotic fibrosis and because of the lack of collapsibility also due to the fibrosis.

It is concluded that the prevalence of tuberculosis in silicotic coal miners is probably about 12 to 15 per cent rather than the extremes of 3 and 75 per cent which have been suggested. Most of the tuberculosis is found in patients with third-stage silicosis.

Eleven roentgenograms; 3 graphs; 8 tables.

JOHN H. JUHL, M.D.
Minneapolis, Minn.

The Harvard Public-Health Chest Clinic. Milton Elkin and Merrill C. Sosman. New England J. Med. **245**: 930–933, Dec. 13, 1951.

A review is given of the experience at the Harvard Public Health Chest Clinic. The groups surveyed were as follows: students at Harvard Medical School and the Harvard School of Public Health; employees of three hospitals, including nurses, interns, and residents, as well as non-professional employees; clinic patients at the Boston Lying-in Hospital (women in the early stages of pregnancy); clinic patients from Peter Bent Brigham Hospital sent in at the discretion of the examining physician (all new patients were examined); a miscellaneous group consisting of referrals from practising physicians, a neighboring small hospital, and students and employees from a few schools in the vicinity.

During a thirty-three-month period, 30,519 70-mm. films were made; 513 (1.5 per cent of the total) suggested active pulmonary tuberculosis and further

studies were recommended. Of this latter group, 454 had adequate follow-up, 72 being proved to be cases of active disease (0.24 per cent of the total films taken). Forty-seven per cent of the 72 cases were shown to be minimal in extent. Disease was discovered in 20 hospital employees, 15 pregnant women, and 3 medical students.

It is estimated that in this survey it cost about $300 to discover an active case of tuberculosis. When one considers only the economic aspects of tuberculosis (the average patient in Massachusetts costs the community $3,700 for 330 days of hospitalization), the apparently large cost of finding an active case really accomplishes a significant economic saving. Also, in the particular groups covered by the survey—notably women in the early months of pregnancy and hospital personnel who come in contact with many debilitated patients—the discovery of active cases has further important implications.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Screening for Chest Pathology Using Mass X-Ray Survey Technic. G. Howard Gowen and Bernard Frank. Ann. Int. Med. **36:** 138–145, January 1952.

In a chest survey of 156,724 persons in widely scattered areas, both urban and rural, in Illinois (all outside of Chicago), between April 1949 and March 1950, evidence suggestive of neoplasm was found on 307 films, or 0.2 per cent. The survey included 53,000 persons forty-five years of age and over. To the questionnaires sent to physicians regarding these cases, 165 replies of an informative nature were received. This group showed 10 primary carcinomas of the lung, of which 9 were well advanced.

The authors also undertook a follow-up of cardiac suspects (referred by the Division of Tuberculosis Control) as determined from evidence of cardiac enlargement on the 70-mm. chest film. The period covered was Jan. 1 to April 15, 1950. The number of persons examined was 43,202, of whom 15,108 were forty-five years of age and over. Questionnaires sent out on 217 suspects yielded 92 informative replies. Of these, 16 gave no diagnosis, leaving 76 fully reported suspects, a case rate of 171.29 per 100,000 persons surveyed. The diagnoses were as follows: negative, 2; hypertensive heart disease, 22; rheumatic heart disease, 18; myocardial heart disease, 17; arteriosclerotic heart disease with hypertension, 6; miscellaneous heart disease, 6; arteriosclerotic heart disease without hypertension, 3; coronary heart disease, 2.

Screening devices have certain fundamental aims. They seek to discover disease early, so that the patient may be brought under treatment more promptly. This should lead to the prevention of certain chronic conditions, a decrease in complications, fewer cases needing long and costly care, greater rehabilitation and, of course, the saving of lives. In so far as cancer of the lung is concerned, the aim is cure and rehabilitation. In the case of heart disease, however, the primary aim is not a cure but rather a prolongation of life; at the same time it is hoped, through rehabilitation, to enable the patient to lead as nearly normal a life as possible. We should therefore exercise care in selection, screening only those groups from which we can expect the greatest return.

Ten tables.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

The Open Ductus Botalli in the Roentgen-cine Film. R. Janker. Fortschr. a. d. Geb. d. Röntgenstrahlen **75:** 79–92, (Sonderheft) December 1951. (In German)

Persistent ductus arteriosus is the chief congenital heart condition of the non-cyanotic group amenable to surgical intervention. It is important to establish the exact diagnosis, as closure of the duct, when compensating for other congenital cardiac conditions, may lead to serious results, even to death. The clinical and plain x-ray findings are often sufficient for a diagnosis. However, a machinery murmur may be simulated by other types of murmur and a globular heart configuration, bulging of the pulmonary artery segment, abnormal hilar impulses, etc., may be absent with patent ductus and may be present in other conditions. It is the author's opinion, therefore, that angiocardiography or one of the other special studies should be carried through to rule out other complicating congenital conditions. Heart catheterization with determination of oxygen concentration and pressure readings, as well as retrograde aortography, are extremely difficult in young children.

During the course of 400 angiocardiographic studies, the author established the diagnosis of isolated patent ductus in 18 cases. He recommends the left anterior oblique position and, using the cine method, takes 18 to 24 frames per second. The diagnostic findings are (*a*) dilatation of the pulmonary artery and its branches, (*b*) hypertrophy of the left ventricle, (*c*) absence of evidence of other intercardiac shunts, (*d*) late filling of the pulmonary artery from the aorta, (*e*) occasionally abnormal hilar pulsations. The author claims that the rhythmic pulsations of the pulmonary artery and the late filling of the pulmonary artery direct from the aorta are shown more clearly on the motion picture film than with the usual type of rapid-changing cassettes or roll-film devices.

The advantages of motion picture film in these studies include superior demonstration of individual systole and diastole of the chambers and better visualization of the valves, the ability to observe the continuous passage of the dye in every detail, visualization of the "after filling" of the pulmonary artery. Details of filling and emptying of the chambers, as well as the elasticity of the vessels, are well shown.

Enlarged reproductions of motion picture films are included to show isolated patent ductus with absence of other complications (operative indication); patent ductus compensating for mitral stenosis, showing reverse flow of dye from the pulmonary artery to the aorta in the early frames; patent ductus compensating for infantile coarctation (associated with pulmonary artery aneurysm and ventricular septal defect); patent ductus associated with tetralogy of Fallot, tricuspid stenosis, and pulmonary stenosis.

Angiocardiocinematography, although depending for diagnosis on indirect signs, gives a more complete and accurate picture than other standard method.

Fifty-four roentgenograms.

E. W. SPACKMAN, M.D.
Fort Worth, Texas

Right Heart Catheterization in Patent Ductus Arteriosus and Aortic-Pulmonary Septal Defect. Forrest H. Adams, Antoni Diehl, Joseph Jorgens, and L. George Veasy. J. Pediat. **40:** 49–59, January 1952.

The authors present the results of cardiac cathe-

terization studies in 8 patients with typical patent ductus, in 11 patients with atypical patent ductus, and in 5 patients with aortic-pulmonary defect. The value of the procedure for the diagnosis of atypical patent ductus is stressed.

There is no consistent relationship between the size of the ductus and the amount of blood shunted; however, most of the patients in this study with elevated pulmonary artery pressures had large shunts. In addition, cardiac disability seemed to be related to increase in pulmonary artery pressure. In one case in which catheterization studies led to a diagnosis of aortic-pulmonary artery defect, this was confirmed postmortem. This is believed to be the first recorded instance of antemortem diagnosis of this defect confirmed at autopsy.

Six figures, including 6 roentgenograms; 6 tables.

ALBERT R. BENNETT, M.D.
Mt. Sinai Hospital of Cleveland

Size of the Heart During the Course of Essential Hypertension. Morris Kleinfeld and Jules Redish. Circulation **5**: 74–80, January 1952.

The measurement of the transverse diameter of the heart, when used in conjunction with prediction tables based on height and weight, yields an index of heart size which is probably the simplest and subject to the fewest errors. The chief difficulty in using the mean transverse diameter is the inability to distinguish between early left ventricular enlargement and a normal sized but transversely placed heart. Fluoroscopy may be useful in some cases.

The authors used the above method of determining heart size teleroentgenographically in 45 patients with essential hypertension. The majority of the patients (24) showed progressive cardiac enlargement from the time of discovery of hypertension, regardless of the initial measurement. In 18 patients the size of the heart remained stationary for as long as ten years or more. In 3 instances the heart manifested sudden enlargement sometime during the course of observation and continued to progress in size regardless of the initial measurement.

With respect to the effect of factors such as congestive heart failure, myocardial infarction, degree of hypertension, and weight loss, the following facts were noted: (*a*) Congestive heart failure was found to occur with normal heart measurements. This was observed in 5 of 14 patients. (*b*) No uniform relationship could be established between the size of the heart and myocardial infarction, although myocardial infarction was followed in some patients by sudden cardiac enlargement. (*c*) Weight loss of 20 to 40 pounds did not result in a reduction in the size of the heart. (*d*) No direct relationship could be established between the duration and the degree of hypertension and the size of the heart. The finding of normal cardiac measurements in the course of hypertension of a decade or more was not unusual. (*e*) Marked cardiac enlargement was present in 4 patients for ten or more years with little function limitation.

Prognosis on the basis of the size of the heart alone was found to be unwarranted. Cardiac size is only one facet in the clinical picture. The inclusion and evaluation of all factors is important in determining the probable outcome in a given case.

Six tables.

MARIO TAMBURINI, M.D.
Pittsburgh, Penna.

THE BREAST

Roentgenology and Pathology of Cyclic Disturbances in the Breast, with Special Reference to Their Surgical Diagnosis. Jacob Gershon-Cohen and Helen Ingleby. Surg., Gynec. & Obst. **94**: 91–102, January 1952.

The detection of benign lesions of the breast by clinical and x-ray examination should make it possible to reduce with safety the large number of biopsies now being performed for lack of adequate diagnostic methods. The failure of radiology to prove its worth in this field is due largely to lack of correlation between x-ray and pathological findings. With a view to correcting this situation, a study was made of 200 consecutive cases which came to operation at the Jewish Hospital, Philadelphia. This was based on lateral and tangential x-ray studies of both breasts, as well as serial sections of the operative specimen by slicer method, and frozen and paraffin sections.

The authors suggest the following classification of breast diseases: (1) mazoplasia, Groups I and II; (2) fibroadenoma; (3) secretory cystic disease with or without plasma-cell mastitis; (4) papilloma; (5) Schimmelbusch disease (mastopathy); (6) carcinoma.

The clinical history and pathology of each of the benign conditions are discussed, as well as the x-ray findings. In Group I mazoplasia the roentgen picture is characterized by a uniform, homogeneous tissue density. The anterior contour of the glandular portion of the breast is smooth and regular. Pathologically, Group II mazoplasia shows cyst formation as well as intraductal fibrosis, and the cysts may be delineated roentgenographically by their clear sharp outlines and bulging displacement of the stroma and surface. Fibroadenomas are not usually demonstrable by x-ray except in the aged. Their diagnosis is suggested by a palpable tumor invisible roentgenologically. In older people, their slightly irregular outline may differentiate them from cysts and they may show calcification.

In secretory cystic disease, the roentgenogram will show coarse, often flame-like digitations running in the line of the breast trabeculae. Should plasma-cell mastitis supervene, a localized tumor surrounded by edema appears. In intraductal papillomas, the affected ducts are elongated and varicose, and the picture may bear some resemblance to secretory cystic disease. Intracystic papillomas are easily seen due to their hemosiderin content (from hemorrhage), which is radiopaque. Schimmelbusch's disease cannot be distinguished from mazoplasia, Group II, except for greater architectural distortion.

The role of hormonal imbalance in the production of these lesions is discussed. If such factors are clearly understood along with their resultant effects in the breast, roentgenology can contribute appreciably to the diagnosis of benign breast lesions.

Eight roentgenograms; 7 photomicrographs.

ROBERT P. BOUDREAU, M.D.
University of Pennsylvania

THE DIGESTIVE SYSTEM

Polypoid Tumors of the Esophagus (Sarcoma, Melanoma, Mixed Tumors, Double Tumor). M. Lüdin. Fortschr. a. d. Geb. d. Röntgenstrahlen **75**: 117–122, (Sonderheft) December 1951. (In German)

Polypoid tumors of the esophagus include fibroma,

lipoma, sarcoma, and so-called mixed tumors. They are relatively infrequent. Clinically the sarcoma and mixed tumors generally resemble carcinoma. The chief complaint is dysphagia, which is often the only outstanding symptom of carcinoma. Sarcoma patients are more likely to have pain, sometimes during the night, between the shoulder blades, occasionally with a moderate rise in temperature. Carcinoma patients show more tendency for the growth to encircle the entire lumen of the esophagus and there are frequently present, especially in the later stages, secondary anemia, increased sedimentation rate, and emaciation. Polypoid tumors produce slight symptoms, as the esophagus will expand to compensate for the size of the growth.

Accurate roentgenologic differentiation is difficult, but certain characteristics are noted. A mass lesion can be identified by narrowing of the lumen; a long narrow pattern is strongly indicative of fibroma or lipoma. A broad base attached to the esophageal walls suggests sarcoma or mixed tumor.

The author reports two sarcomas, one malignant melanoma, one mesenchymal mixed tumor, and one double tumor (sarcoma and carcinoma). All the patients were over fifty years of age.

Five roentgenograms; 3 photographs.

E. W. SPACKMAN, M.D.
Fort Worth, Texas

Regarding Various Acute Abdominal Syndromes in Internal Medicine and Their Roentgen Diagnosis. H. H. Berg. Fortschr. a. d. Geb. d. Röntgenstrahlen **75:** 1–9, (Sonderheft) December 1951. (In German)

We do not usually think of the "acute abdomen" as a medical problem, but many conditions arise in which medical consultation as well as surgical intervention is indicated. In cases of medical interest as well as surgical cases, radiology is of value for the interpretation of acute abdominal distress. The author analyzes and briefly discusses the following acute abdominal conditions:

A. Chemical and metabolic
   1. Ketosis (diabetic)
   2. Azotemia
   3. Postoperative acidosis (salt depletion)
B. Spasticity
   1. Primary (local irritation)
   2. Secondary (reflex)
      a. Postoperative colic
      b. Peritoneal irritation
      c. Urinary colic, etc.
      d. Reflex from pleura and lung
C. Paralytic ileus
D. Association with other diseases
   1. Central nervous conditions
   2. Tabetic crises
   3. Metal and other poisonings
E. Inflammations
   1. Organic
   2. Peritonitis
   3. Enteritis
   4. Abscesses
F. Mechanical
   1. Volvulus and torsions of organs
   2. Obstruction
   3. Intussusception
   4. Hernia
   5. Adhesions
   6. Trauma
G. Perforations and fistula
H. Internal hemorrhage

A. In chemical and metabolic conditions treatment of the underlying acidosis or uremia is of supreme importance. Operation is by no means indicated.

B. In spastic conditions medication is very frequently the initial treatment of choice and a careful appraisal of the individual case will obviate unnecessary surgical interference.

C. The underlying cause of paralytic ileus is to be determined and corrected. This may require medical or surgical measures, but a careful differentiation is necessary.

D. Tabetic crises, disease of the central nervous system, etc., have on many occasions given rise to severe acute abdominal symptoms and operations have been unnecessarily performed where medical measures were indicated for relief of the acute symptoms.

E. Various inflammatory conditions, especially when resulting in abscess formation, may be eventually surgical problems, but their preoperative management sometimes is of the greatest significance. The author particularly stresses differentiation between parenchymal and extrahepatic biliary disease by serum alkaline phosphatase determinations. Higher values are obtained in the obstructed cases than in hepatitis or cirrhosis.

F. Mechanical obstructions are usually surgical problems, but judicious use of the Miller-Abbott tube and other preoperative measures are essential.

G. Perforations, fistulas, and ulcers, excluding benign gastric ulcers, are usually surgical problems, but attendant medical measures to relieve shock, build up the patient's resistance, and fight infection are also important.

H. Internal hemorrhage may occasionally be best handled by medical measures. The author points out cases in which gastric bleeding with clot formation may simulate carcinoma.

By close collaboration and careful study from both surgical and medical standpoints, unnecessary operations may be avoided; preoperative medication may contribute greatly to the outcome of a case and in many instances may take precedence over surgery.

Six roentgenograms. E. W. SPACKMAN, M.D.
Fort Worth, Texas

Roentgen Diagnosis of Acute Abdominal Conditions. Leah Shore Finkelstein and Arthur Finkelstein. S. Clin. North America **31:** 1603–1631, December 1951.

This article is written for the general reader and attempts to cover an important field in a relatively short space. As a result, many of the diagnostic possibilities are barely touched upon. The authors present a rather complete table of possible causes of acute abdominal conditions.

The importance of immediate competent roentgenologic investigation is emphasized. Supine and erect plain films comprise the minimum examination. Lateral decubitus and other special views should be obtained as needed. Depending on the clinical history and upon the results of the initial study, special procedures such as urography, colon examination, etc., should be done as indicated.

Most of the discussion deals with intestinal obstruction (ileus). The diagnosis of mechanical obstruction of the small intestine and of the colon and of paralytic ileus is discussed in some detail. The importance of repeated films in the differential diagnosis is stressed.

If possible, cleansing enemas should be avoided prior to roentgen study. They frequently confuse the picture by introducing air into the colon, although occasionally they may help by clearing the colon below the site of obstruction.

If the preliminary picture is not clear-cut, or if the findings suggest large bowel obstruction, a barium enema study should be done at once. The many causes of colonic obstruction (neoplasm, intussusception, volvulus, adhesions, etc.) cannot be determined without such studies.

The article is of value in that the non-radiologist may obtain from it considerable knowledge and information as to what may be expected from roentgenology in the differential diagnosis of acute abdominal conditions.

Twenty-seven roentgenograms; 1 table.

JAMES GROVE, M.D.
Mt. Sinai Hospital of Cleveland

Clinical Studies on the Use of Controlled Intragastric Pressure for the Roentgen Diagnosis of Lesions in and about the Fundus of the Stomach. Everett L. Pirkey, Herbert D. Kerman, Edsel S. Reed, William H. Smith, and Gabriel Whiteman. Am. J. Roentgenol. **67:** 217–226, February 1952.

The relative inaccessibility of the fundus of the stomach to palpation has proved a serious handicap to its roentgenologic examination. Yet approximately 5 per cent of gastric tumors are found in the upper half of the stomach.

The authors report the findings in 54 cases of suspected gastric disease in which they used an inflated balloon. (See Pirkey: Am. J. Roentgenol. **62:** 70, 1949) to study the elasticity, mobility, and motility of the portions of the stomach not normally accessible to palpation. Films are made in various positions with barium in the most dependent portion of the stomach. Stereoscopic films in both the right anterior oblique and left anterior oblique are obtained routinely.

Of the 54 cases, 16 showed lesions (proved) in or about the fundus of the stomach. In each instance the authors were able to differentiate between an intrinsic and an extrinsic lesion by studying what they call the "profile line." The "profile line" is produced when a layer of barium is trapped between the balloon and the gastric mucosa. This is seen whenever normal mucosa is present but not with pathological infiltration of the mucosa. Numerous roentgenograms are reproduced, illustrating the presence and absence of the "profile line" and the differentiation between intrinsic and extrinsic defects.

Twelve roentgenograms; 1 drawing; 2 tables.

BERTRAM LEVIN, M.D.
Minneapolis, Minn.

Perigastric Adhesions and Bands Involving the Pyloric Antrum. A Diagnostic Enigma. Edward L. Jenkinson, William H. Pfisterer, Ruskin C. Norman, and Karl K. Latteier. Am. J. Roentgenol. **67:** 210–216, February 1952.

The authors report the findings in 7 cases of prepyloric deformities due to adhesions and bands which were roentgenologically compatible with deformities produced by a malignant growth.

All patients were over fifty years old and all complained of weakness and epigastric distress. One had a history of vomiting, 2 complained of pressure and fullness about the heart, and all suffered from aftermeal distress. Every one of the 7 patients had signs of gastrointestinal bleeding and two had achlorhydria. All had occult blood in their stools.

In each case some form of prepyloric deformity was noted at roentgenologic examination. In most cases the pyloric antrum was narrowed, fixed, and rigid. Each patient was operated upon with a preoperative diagnosis of prepyloric cancer. In 1 case the deformity was found to be due to an adhesive band which was continuous with the lower border of the liver and the falciform ligament and which surrounded the pylorus, producing a funnel-shaped narrowing of the pyloric antrum. Another pyloric deformity was caused by the gastrohepatic ligament, which was attached to the lesser curvature of the stomach, fixing and elevating the pylorus. In 2 cases surgical exploration revealed an adhesion between the greater omentum and the pylorus, displacing the greater curvature. In 2 others pyloric deformity was the result of post-cholecystectomy adhesions which contracted and absolutely fixed the pyloric end of the stomach in position. The peristaltic waves had ended abruptly at the area of narrowing. In the last case the marked pyloric deformity, rugal distortion, and inhibition of peristalsis were due to marked fibrosis secondary to an old ulcer at the base of the duodenal bulb.

The developmental and adult relationships of the mesentery and its ramifications which may account for pyloric deformity are discussed.

Nine roentgenograms; 5 drawings.

BERTRAM LEVIN, M.D.
Minneapolis, Minn.

Prolapse of the Mucous Membrane of the Stomach into the Duodenum. W. Schröder. Fortschr. a. d. Geb. d. Röntgenstrahlen **75:** 661–669, December 1951. (In German)

Much has been written in the past few years about the prolapse of the mucous membrane of the stomach into the duodenum. The roentgen appearance is described as a defect in the barium filling of the base of the duodenum adjacent to the pylorus, giving the duodenum the shape of a mushroom or perhaps of an open umbrella. The defect consists of several tongue-like sections with intervening strips of barium, said to lie within the valleys between the mucosal folds. In the American literature this condition is described as being often associated with hyperperistalsis.

The author has examined freshly resected specimens and has found that the mucous membrane, being only loosely attached to the muscular coat of the stomach, permits a good deal of sliding. In the prepyloric region the mucosa can be slipped forward normally for a distance of 1 cm. or more in most instances. In the reported cases of prolapse the mucous membrane is usually hypertrophied and congested.

The author thinks that, in most of the cases described as prolapse, a pathological movement of the mucous membrane does not exist. He believes that, in the presence of mucosal hypertrophy and of some hyperperistalsis, the mucous membrane may be moved forward within its normal physiological limits and

produce a picture resembling a prolapse. He does not want to say that a real prolapse cannot exist, but he regards it as extremely rare and feels that it should be diagnosed only if the back-and-forth movement of the mucous membrane through the pylorus can be definitely demonstrated fluoroscopically, as when a polyp of the mucous membrane of the stomach can be made to slide backward and forward through the pylorus. In one of his own cases in which operation was done for what used to be called a prolapse, the resected specimen showed only chronic gastritis with hypertrophied mucosa.

In roentgen interpretation, therefore, the findings usually called prolapse should be described as hypertrophied mucous membrane of the stomach associated with hyperperistalsis. This condition may be due to a great variety of causes, which are not apparent from the x-ray examination. It may be the result of chronic gastritis or of certain congestive changes in connection with cardiac pathology, etc. Whether the hyperperistalsis, perhaps on a neurogenic basis, was the primary agent producing a loosening of the mucous membrane and hypertrophy, or whether an inflammatory condition in the mucous membrane produced the hyperperistalsis, cannot be determined.

Eight figures, including 15 roentgenograms.

WM. A. MARSHALL, M.D.
Chicago, Ill.

Duodenocolic Fistula. Lee M. Hershenson and Joseph B. Kirsner. Gastroenterology **19**: 864–873, December 1951.

The authors report a case of fistula between the descending duodenum and the right half of the colon. This they believe is the 32nd case of duodenocolic fistula to appear in the literature.

In 19 of the 29 proved cases, the fistula arose from a carcinoma of the colon; in 1 instance it was due to carcinoma of the duodenum. In these cases, though there was invasion of the duodenal wall by carcinoma, the fistulous tract in many instances was composed partly of inflammatory tissue. The causes of the remaining cases included peptic ulcer, tuberculosis, and post-resection regional ileitis. A possible cause in 1 case was typhoid ulceration.

The most important single procedure in the diagnosis of duodenocolic fistula is the barium enema examination. In none of the cases in which the findings of this examination are reported did it fail to reveal the fistula. This is a much better way of determining the correct diagnosis than study by the barium meal.

These patients present a characteristic clinical picture, consisting of mild epigastric or right-sided abdominal pain and persistent diarrhea, with occult blood and often undigested food in the feces. In addition, vomiting or belching may be present and there usually is severe weight loss and malnutrition, as well as anemia. In cases due to benign lesions, diarrhea may be absent.

The treatment of duodenocolic fistula is surgical and in the presence of carcinoma must be quite radical. Every care should be made to have the patient in the best possible condition prior to surgery.

The case reported here was due to an adenocarcinoma of the accending colon which had invaded the second portion of the duodenum. An interesting feature of the case was the presence of a separate adenocarcinoma of the sigmoid and multiple polyps elsewhere in the colon.

One roentgenogram; 4 photographs; 2 tables.

JAMES GROVE, M.D.
Mt. Sinai Hospital of Cleveland

Carcinoma of the Colon. J. Montgomery Deaver and Edwin W. Shearburn. S. Clin. North America **31**: 1763–1768, December 1951.

The authors report 100 consecutive cases of carcinoma of the colon excluding the rectum. In only one-half of the patients did the surgeon hope to obtain a cure, once the abdomen was opened, and of this latter group, only two-thirds were living at the time of the report, most of whom had not yet reached the five-year follow-up.

Pain was a presenting symptom in two-thirds of the cases, which seems rather high. Constipation occurred in half of the patients, being especially common with left-sided lesions. Melena, weight loss, and obstructive symptoms were frequently the reason for seeking medical attention. The diagnosis was made or suspected preoperatively in all cases. With a few exceptions, all the patients were studied roentgenographically and by proctosigmoidoscopy. Diverticulitis with abscess or granuloma were the only conditions which proved to be confusing on roentgenologic examination.

The exact surgical procedures done are reported in some detail. Even if the object is only palliation, resection and anastomosis are to be preferred to colostomy.

Four tables.

ALVIN J. GREENBERG, M.D.
Mt. Sinai Hospital of Cleveland

Diverticulitis of the Colon Complicated by Carcinoma. Collective Review. Robert J. Rowe and George H. Kollmar. Internat. Abst. Surg. **94**: 1–9, January 1952. In Surg., Gynec. & Obst., January 1952.

The clinical manifestations and gross appearance of diverticulitis and carcinoma of the large bowel are often indistinguishable, yet the currently favored handling of diverticulitis involves staged surgical procedures, extending over many months. Since this delay in resection of the involved segment of bowel unfavorably affects the prognosis in the event that a carcinoma is present, the authors advocate more frequent primary resections and anastomoses except in the presence of marked inflammation or fistulas.

The authors trace the development of the current concept that diverticulitis and carcinoma of the bowel rarely coexist, and that their occasional concomitant occurrence is coincidental, reflecting no pathogenic relationship. This concept is supported by the authors' finding of only 62 cases of the proved coexistence of these lesions in the English literature and further by a survey of six hospitals and fifty surgeons' records, revealing only 7 additional cases.

A case is presented to illustrate the danger to the patient in staged procedures in the presence of carcinoma and also the hazard of introducing barium into a segment of bowel proximal to an obstruction.

The clinical signs and symptoms and the roentgenographic and sigmoidoscopic findings in carcinoma and diverticulitis are presented in tabular form. The symptomatology is of little value in the differentiation of the two entities. The presence of a palpable mass

or fistula is more common with diverticulitis, whereas evidence of obstruction, anemia, and cachexia favor the diagnosis of carcinoma. Papanicolaou smears obtained on sigmoidoscopy may be useful in establishing the presence of a carcinoma. The most useful diagnostic tool is the roentgenologic examination.

The radiographic findings suggestive of diverticulitis are the presence of a spastic bowel, the "cone shape" of the defects, the involvement of long segments of bowel with preservation of the mucosal pattern, and the presence of diverticula. Carcinoma is manifest by the presence of normal bowel adjacent to the lesion, a "shelf shaped" defect, involvement of a short segment of bowel, and loss of mucosal folds.

Five roentgenograms; 5 tables.

WILLIAM J. TUDDENHAM, M.D.
University of Pennsylvania

The Inflammatory Factor in Malignant Lesions of the Colon. Frederick A. Bothe. S. Clin. North America **31**: 1753–1761, December 1951.

Many times patients operated upon for extensive lesions in the colon live far longer than was anticipated from the size of the lesion and the extent to which it was adherent to surrounding structures.

Numerous factors are responsible for the discrepancy between the postoperative survival period and the expectation of the surgeon at the time of operation. Among these is inflammation. In his discussion of this factor, the author considers the postoperative x-ray findings, showing how these form a base line for future roentgenograms for determining early recurrence or other causes which may be producing symptoms. If, however, the postoperative roentgen studies are made too soon after operation the presence of spasm, inflammation, and edema around an anastomosis may be responsible for deformities which will confuse the picture. Experience has shown that these complicating factors usually disappear in about five months and that a barium enema study made after that interval furnishes a much more satisfactory base line. Follow-up x-ray studies are done every six months up to two years following operation and after that, if no symptoms are present, once a year. Should symptoms develop, the interval and frequency of roentgen check-ups must be individualized, since there is a wide variation in types of patients. Should any defect be found in future x-ray studies, one can be safe in considering that a recurrence has developed and be justified in recommending surgical exploration.

Three roentgenograms.

Roentgen Appearance of Intestinal Pouches Following Lateral Anastomoses. Hyman R. Senturia and Carl J. Heifetz. Am. J. Roentgenol. **67**: 227–239, February 1952.

The authors note that blind pouch formation following side-to-side (lateral) intestinal anastomosis after division of the bowel frequently produces symptoms which may simulate partial intestinal obstruction.

Lateral anastomosis results in two blind ends of intestine. The proximal end can act as a reservoir for foreign matter, with the occasional production of serious complications. The work of Pearse on 60 dogs is recounted (Surg., Gynec. & Obst. **59**: 726, 1934). Blind loops of different lengths were observed roentgenoscopically after filling with barium. Peristalsis began near the anastomosis and swept forward toward the blind end. As the strength of the waves increased, the incisura caused by them deepened, and barium was carried up to the blind end, which became dilated. It was concluded that, when the direction of peristalsis is away from the blind end and toward the anastomosis, the segment of intestine remains empty. In the segment above the obstruction, where the peristaltic current is from the anastomosis toward the blind end, material is carried into the blind segment and retained.

A number of cases are culled from the literature in which such symptoms as pain, vomiting, distention, diarrhea, and constipation could be attributed to blind segments of small bowel left after division of the intestine and lateral anastomosis. In a number of instances cures resulted when the blind pouch was resected and/or end-to-side anastomosis was performed after breaking down the old lateral anastomosis. In one series of ileocolostomy cases, studies revealed that the ileal loop directly proximal to the anastomosis or immediately adjacent to it was dilated in about one-third of the patients.

The authors report and illustrate 6 cases in which the distended intestinal pouch was identified roentgenographically and at operation. Three patients had symptoms directly attributable to the blind pouch.

The blind pouches can be identified on both the small bowel study and by barium enema, the pouch being clearly outlined by retained barium. "Unwarranted surgery can be avoided or curative surgery can be performed if the correct interpretation of the roentgen findings is made."

Ten roentgenograms; 2 drawings; 1 photograph.

BERTRAM LEVIN, M.D.
Minneapolis, Minn.

THE MUSCULOSKELETAL SYSTEM

Osteopetrosis (Albers-Schönberg Disease). Karl Schulte. Fortschr. a. d. Geb. d. Röntgenstrahlen **75**: 720–724, December 1951. (In German)

Osteopetrosis is an hereditary disease characterized by generalized osteosclerosis of the skeleton, abnormal fragility of the bones, and secondary anemia. Other changes which may be present are disturbances of certain cranial nerves, particularly the acoustic and the optic nerves, leading to impairment of hearing and to blindness; osteomyelitic processes, especially of the upper jaw; calcifications in other organs; growth disturbances; changes of the teeth; increased serum calcium. The etiology is unknown. Pathologically the cancellous bone is replaced by massive compact bone. The marrow cavities disappear and the bone becomes fragile. Deformities are common. Fractures occur frequently.

The x-ray films are quite characteristic. The bones show a markedly increased density. The films appear to be underexposed. In the skull it is chiefly the base which appears to be dense. The following conditions must be differentiated: generalized osteoplastic carcinosis, osteosclerosis in lead poisoning, phosphor or fluorine poisoning, Paget's disease, and osteitis luetica.

The author reports the case of a 46-year-old farmer who sustained a fracture of the thigh which led to the diagnosis. This patient had all the characteristic x-ray appearances of osteopetrosis. He also had a high blood calcium, but did not have an anemia.

Nine roentgenograms.

WM. A. MARSHALL M.D.
Chicago, Ill.

Chondro-osteo-dystrophy. James F. Brailsford. J. Bone & Joint Surg. **34-B:** 53–63, February 1952.

Chondro-osteo-dystrophy was so labeled by the author when he described a case in 1928. Since that time he has collected 5 similar cases and has described the roentgen findings from films taken during sixteen or more years of life.

The chief radiographic observations in the early stages were as follows:

Skull: No appreciable change from normal.

Spine: The outlines of the bodies and processes are irregular and ill-defined. The bodies are flattened, some showing an anterior tongue with no ossification in the upper and lower epiphyseal sites, some being slipper-shaped and of irregular size. A lateral curvature is frequently present in the thoracolumbar region. In the cervicothoracic area the compression is associated with shortening of the neck; in the thoracolumbar region a kyphosis has been seen associated with vertebral bodies irregular in size and shape; the disk spaces may be as deep as the flattened vertebral bodies. With increased flattening of the vertebrae, the sternum is pushed forward progressively.

Extremities: The long bones have been of normal density and have not shown any unusual fragility. The epiphyses contain multiple ossific areas and the diaphyseal extremities are irregular in ossification. The joint spaces, more particularly of the shoulder, wrist, hip, knee, and ankle joint, are considerably widened, suggesting overgrowth of cartilage. The nuclei for the carpal and tarsal bones show delay in development and marked irregularity of outline.

The later radiographic features showed no interval change in the skull, but the epiphyses of the larger joints, notably the hip joints, deteriorated. The ossific nuclei, which had originally been well formed, disappeared, and no further ossification in them occurred. The musculature became progressively weaker with the result that the joints became unstable and dislocation at the hip joints occurred. The acetabula expanded to the anterior spine, and the upper end of the femora (which tend toward valgus deformity) came into cartilaginous apposition with the lateral aspect of the ilia, but later this connection was lost and the joints became somewhat flail, the opposing bony surfaces being irregular in outline, separated probably by dystrophic cartilage. At the knee joint, because the epiphyses are ossified from multiple nuclei without the stability of normal entire homogeneous nuclei, and because the ossification of the diaphyseal extremities is irregular and mechanically unsound, knock-knee deformity develops without any bowing of the shafts of the diaphyses as in rickets. In the forearm, however, the dystrophic changes at the wrist are associated with bowing due to irregular growth.

The condition occurs in both sexes and "is associated with some lethal factor in the parents introducing a state of incompatibility." One cannot entirely rule out immaturity of parents or the employment of abortifacients. Though syphilis is a common cause of developmental defects, it was not present in any of the cases described. It has been shown experimentally that irregularities in development can be produced by agents which result in checking growth, which interfere with oxygenation, or which are responsible for toxic products.

In all cases there appears to be induced an associated constitutional weakness, so great in some as to be incompatible with life; in others, it is less severe, the infant survives a few years and then succumbs to pneumonia or, as in the case of the author's original patient who died at fourteen years, to a progressive degeneration of all the skeletal tissues. In other cases, the dystrophy shows progressive development and results in dwarfing of the skeleton and weakness of the musculature.

The author elaborates on the differential diagnosis, which includes rickets, hypothyroidism, osteochondritis, achondroplasia, and gargoylism.

Seventeen roentgenograms; 5 photographs.

DANIEL WILNER, M.D.
Atlantic City, N. J.

Dysplasia Epiphysialis Multiplex in Three Sisters. W. Waugh. J. Bone & Joint Surg. **34-B:** 82–87, February 1952.

Dysplasia epiphysialis multiplex was first described by Fairbank (Brit. J. Surg. **34:** 225, 1947. Abst. in Radiology **50:** 130, 1948). It is characterized by dwarfism, stubby digits, and mottling or irregularity in density and outline of the developing epiphyses.

The three sisters described in this paper were short, with short stubby hands and feet, and all had cleft palates. While all showed, to a varying degree, epiphyseal changes characteristic of the condition, there was one striking feature in which the findings differed from the description given by Fairbank. He states that "the centers of ossification for the epiphyses may be late in appearing and backward in development and fusion with the shaft may be delayed." In the author's cases, the epiphyses appeared early and fused early, and a study of the bone detail showed a remarkable degree of maturity for the age of the patients. Fairbank emphasized that "the principal change is irregularity in ossification," and the three sisters showed almost typical features in this respect. In one sister, the capital epiphyses in the hips were flattened, narrow, and irregularly developed. The neck of the femur was widened and there was coxa vara. Another sister had an abnormality of the lower femoral epiphysis, causing the knock-knee for which she was treated. The patella on the same side was absent. The ankles in each sister showed a flattening of the superior articular surface of the talus in the lateral view. The feet showed abnormalities of the tarsus and shunted metatarsals. In the hands the metacarpals were broad and short. In one of the sisters the lower end of the humerus and head of the radius were of unusual shape.

If this condition is diagnosed early in life, there should be no need of a dismal prognosis, for dwarfism is seldom severe, deformity has been troublesome only in a small proportion of the reported cases, and function is invariably good.

Nine roentgenograms; 3 photographs; 1 table.

DANIEL WILNER, M.D.
Atlantic City, N. J.

Hereditary Osteo-Onycho-Dysplasia. Wolfgang Roeckerath. Fortschr. a. d. Geb. d. Röntgenstrahlen **75:** 700–712, December 1951. (In German)

The author has designated as "hereditary osteo-onycho-dysplasia" (HOOD) a group of hereditary deformities and dysplasias which occur sufficiently frequently in combination to warrant regarding them as a special disease entity. The various characteristics, according to their frequency, are as follows:

1. *Dysplasia of the Pelvic Girdle:* Iliac horns are bone protrusions originating from the iliac bones adjacent to the middle of the sacroiliac joints and reaching a height of between 1 and 4 cm. Sometimes they can be palpated through the gluteal muscles. Hypoplasia of the iliac bones, protrusion of the acetabula, coxa valga, and an arch sacrum are also found occasionally.

2. *Dysplasias of the Knee Joint:* The patella is either absent or underdeveloped with an inclination to lateral subluxation. There are hyperplasia of the inner condyle of the femur, with hypoplasia of the outer condyle, and hypoplasia of the head of the fibula.

3. *Dysplasias of the Nails:* Most frequently found are dysplasias of the nails of the thumbs and of the index fingers. The nails are either entirely absent or are poorly developed, grow very slowly, show some longitudinal furrows, are splintered, and appear to be flat or concave instead of convex.

4. *Anomalies of Pigmentation of the Iris:* Ordinarily, the inner ring of the iris, measuring perhaps 1.0 mm., is formed by the ectoderm, while the remainder is formed by the mesoderm. In this disease, the section formed by the ectoderm is much larger and usually dark. As most of the patients have light eyes, the large dark ring is quite obvious.

5. *Dysplasias of the Elbow:* The findings are analogous to those in the knee joint. There are hyperplasia of the ulnar epicondyle of the humerus and a hypoplasia or aplasia of the head of the radius.

6. *Dysplasias of the Foot:* Thickening of the malleoli and some degree of clubfoot are frequent.

7. *Dysplasias of the Arm and Hand:* There may be a Madelung deformity with luxation of the lunar bone and thickening of the styloid process of the ulna.

8. *Dysplasias of the Shoulder Girdle:* Hypoplasia of the shoulder blades, subluxation of the clavicle in the acromioclavicular joint, and flattening of the head of the humerus may be observed.

9. *Hyperostosis Frontalis of the Skull.*

Of these characteristics, the iliac horns are the most common. In fact, their presence might be called a detector symptom of the whole complex of dysplasias. The author has studied a family tree and has found that all of the members had iliac horns, in addition to some of the other characteristics. Some of the members were not much inconvenienced by these dysplasias and led a fairly normal life. Others were constantly under orthopedic treatment.

In conclusion, the author discusses the various theoretical considerations regarding the inheritance of the disease. He believes it represents a dominant trait which is not sex-linked.

Thirteen roentgenograms; 1 photograph; 1 chart; 2 tables.

[A number of reports of this syndrome have recently appeared in the American and foreign literature. See the Editorial in Radiology **59**: 578, 1952.—Ed.]

WM. A. MARSHALL, M.D.
Chicago, Ill.

Primary Malignant Bone Tumors. Leonardo Guzmán. Cancer (Edited by the Chilean League Against Cancer) **7**: 140–171, 1950.

The author offers here an exhaustive critical review of the literature on primary malignant osseous tumors, including a summary of the findings in 100 primary sarcomas of bone, in 60 of which a histologic study was made. Criticism is directed against the classification adopted by the American College of Surgeons, and a classification is proposed which is simpler and more comprehensible for the surgeon in general practice, the radiologist, and the pathologist. The various etiologic factors were studied and prominence is given to experimental and clinical work in which gamma radiations have played a part, with a view to restricting their use to strictly indispensable indications.

With a view to establishing the diagnosis, attention is called to the symptom of pain (especially in adolescence). Investigation to find the cause and to confirm or exclude a probable malignant osseous tumor is essential. Emphasis is placed on the need of multiple film studies and other laboratory and biopsy tests, including diagnostic puncture. Biopsy carries less menace for the patient than procrastination or unjustified treatment. Diseases are listed which may be confounded with sarcoma of bone. The various means of treatment known today, surgery, irradiation from without, isotopes, Coley's toxin and chemotherapy (nitrogen mustard and stilbamadine), are discussed with their respective indications.

Statistics are quoted from the literature and those of the Chilean National Radium Institute (of which the author is director) are presented. The author opines that the confusion which has existed and still exists concerning the diverse nature of the different types of malignant tumors developing in bone has influenced the results obtained. These results could be greatly improved with a better comprehension of the pathologic aspects of these affections. Malignant osseous tumor should not be considered always hopeless; the statistics bear this out. JAMES T. CASE, M.D.
Santa Barbara, Calif.

Charcot Joints and Infectious-Vascular Lesions of Bones in Diabetes Mellitus. Barkley Beidleman and Garfield G. Duncan. Am. J. Med. **12**: 43–52, January 1952.

In the available medical literature to date only 23 cases of Charcot joints were found in patients with diabetic neuropathy. Typically, these patients have had poorly controlled diabetes for many years, with gradual development of signs and symptoms of severe neuropathy and little or no concomitant vascular insufficiency or infection. The lesion appears as a swelling of the mid-portion of the foot, with or without pain, and progresses to loss of both arches and finally to total disintegration of the tarsal bones and their articulations. Four cases are presented here.

Many diabetic patients have a second somewhat different type of lesion of the phalanges and metatarsals. These changes, unlike those of the tarsal region, are associated with infection and arterial inadequacy, and occur in extremities in which there are few or no signs of neurologic abnormality. The pathogenesis of this second type of lesion may be open to question. Such lesions of the phalanges and metatarsals are not reported in non-diabetic patients with Charcot joints due to syphilis and syringomyelia in the absence of infected ulcerations or other sepsis. In addition, x-ray changes similar to those described do occur in the feet of otherwise well patients with pyogenic soft-tissue infections involving the periosteum and bone, as an osteitis or early osteomyelitis. Similarly, changes have been found in the distal bones of the foot as a result of vascular insufficiency alone without accompanying infection or neuropathy. Two of the

cases presented illustrated this type of lesion.

Five roentgenograms; 2 diagrams.

HOWARD L. STEINBACH, M.D.
University of California

Charcot Spine Due to Diabetic Neuropathy. Gary Zucker and Maxwell J. Marder. Am. J. Med. **12**: 118–124, January 1952.

A case is presented of typical Charcot spine in a diabetic patient with severe pseudotabes. This appears to be the first case of Charcot spine to be reported as a result of diabetic neuropathy.

The clinical evidence of diabetic neuropathy included absence of deep reflexes, impaired vibratory and position sensation, diminished cutaneous sensation, Argyll Robertson pupils, diminished to absent sweating in the lower half of the body, and impaired innervation of the urinary bladder. Roentgen examination of the lumbar spine disclosed extensive destruction and disorganization of the second, third, and fourth lumbar vertebrae. The third lumbar vertebra was almost completely disintegrated. There was considerable bone production within the area of the destroyed vertebrae. No sclerosis was seen in the adjacent uninvolved bodies. The etiologic and pathologic nature of the lesion was fully corroborated by complete autopsy examination.

Two roentgenograms; 3 photomicrographs.

HOWARD L. STEINBACH, M.D.
University of California

Hypervitaminosis A. A Case Report. John F. Naz and Walton M. Edwards. New England J. Med. **246**: 87–89, Jan. 17, 1952.

A case of hypervitaminosis A in a 9-month-old girl is presented. The clinical findings in this patient were in most respects similar to those observed in previously reported cases. Roentgenograms of the skull, wrists, and ankles, obtained at the age of six months, were regarded as normal; however, a marked periosteal elevation in the clavicles was overlooked in the bone survey. Two months later films of the long bones revealed areas of thickening over the distal shaft of the left ulna and radius, which were considered compatible with rickets and scurvy. It was then discovered that the mother had been giving the child, from the time she was two weeks of age, "8 dropperfuls" of oleum percomorphum (176 drops) daily instead of 8 drops daily. In the light of this information the roentgenographic changes were interpreted as compatible with cortical hyperostosis. Rapid and complete clinical recovery followed withdrawal of all sources of vitamins, but the bone lesions regressed much more slowly.

In the opinion of the authors, faulty excretion contributes to the pathogenesis of the syndrome.

Five roentgenograms; 1 table.

Localised Osteochondritis (Scheuermann's Disease). R. H. V. Hafner. J. Bone & Joint Surg. **34-B**: 38–40, February 1952.

The author presents four cases illustrating a localized form of vertebral osteochondritis occurring in the thoraco-lumbar region. Clinically, there were evidence of pain and tenderness and occasional muscle spasm. Movements of the spine were limited, especially forward flexion. The symptoms subsided rapidly with immobilization of the spine in bed or in a plaster jacket or brace. Radiographically, there was wedging of two adjacent vertebral bodies, often slight at first, but subsequently well marked. In patients seen before the secondary centers of ossification in the epiphyseal rings have appeared, the wedging may be the only abnormality of the vertebral body. After ossification of the rings has begun, other features, such as irregularity of the upper and lower epiphyseal rings, Schmorl's nodes, and sclerosis of the adjacent vertebral surfaces, appear. In all the cases, there was narrowing of the intervertebral disk space between the affected vertebrae, which might suggest a diagnosis of tuberculosis. Bone destruction or rarefaction, either localized or generalized, was never seen, nor was there any evidence of abscess formation.

Three roentgenograms; 1 drawing.

DANIEL WILNER, M.D.
Atlantic City, N. J.

Osteitis Pubis Following Retropubic Prostatectomy. Carl K. Pearlman. J. Urol. **67**: 117–120, January 1952.

In a series of 20 cases in which retropubic prostatectomy was done, severe and disabling osteitis pubis was observed 3 times. The 3 case reports are briefly presented.

Five or six weeks following surgery, pain developed in the legs, walking became painful, and marked tenderness was noted over the pubis. Films revealed the characteristic irregularity and change in bone density at the symphysis. Symptoms persisted for two or three months but the disease proved to be self-limiting and pain gradually eased, permitting return to a normal gait.

In 2 of the cases the periosteum of the pubis was nicked by the point of a needle; in one of these an extended search was necessary to recover the end of a broken needle. In the third case rather vigorous retraction was necessary. The incidence of osteitis pubis was high in this series and the author advises a great deal of caution in employing this procedure.

Four roentgenograms.

JOHN F. RIESSER, M.D.
Springfield, Ohio

The Laurence-Moon-Biedl Syndrome. I. Kessel. J. Pediat. **40**: 96–100, January 1952.

A report of the Laurence-Moon-Biedl syndrome is presented. A five and one-half-year-old South African Bantu exhibited obesity, atypical retinitis pigmentosa, some degree of mental retardation, and polydactylism. The radiological pictures of the hands showed six fingers on each side. On the right side, the supernumerary finger was composed of a proximal phalanx and articulated with a bifid fifth metacarpal bone. On the left side the extra finger was made up of underdeveloped terminal, middle, and proximal phalanges. The fifth metacarpal bone was slightly larger than one might expect. There were seven carpal bones present, which might indicate some advancement in bone age. The roentgenograms of the right foot showed only two phalanges of the fifth toe. On the left foot the little toe showed two sets of middle phalanges articulating with a proximal phalanx, with no skin division between them. The medial phalanx of the double set articulated with the distal phalanx. The terminal phalanges of both fourth toes were underdeveloped.

Classically, the six cardinal features of the Laurence-Moon-Biedl syndrome, in order of frequency, are (1) obesity, (2) retinitis pigmentosa, (3) mental re-

tardation, (4) genital hypoplasia, (5) familial occurrence, and (6) polydactylism.

Three roentgenograms; 2 photographs.

ALBERT R. BENNETT, M.D.
Mt. Sinai Hospital of Cleveland

Congenital Fusion of the Lunate and Triquetral Bones in the South African Bantu. A. B. deVilliers Minnaar. J. Bone & Joint Surg. **34-B**: 45–48, February 1952.

Congenital fusion of the lunate bone with the triquetral has been considered to be rare even in Negroes, who have been regarded as specially subject to this anomaly. The Bantu, with whom this paper is concerned, exhibit this type of carpal fusion fairly frequently. They are a group of Negro peoples who form a native population of southern Africa, to which they appear to have migrated from equatorial Africa.

Lunate-triquetral fusion never causes symptoms. It is always found by accident. It does not appear to be associated with congenital anomalies in the feet. The writer has encountered twelve examples of this type of fusion. The fusions were of four subtypes: (1) incomplete fusion resembling a pseudarthrosis; (2) fusion with a notch of varying depth at the site of the usual division between the two bones; (3) complete fusion of lunate and triquetral alone; (4) complete fusion associated with other carpal anomalies.

The suggestion is favored that fusion represents the persistence of a primitive characteristic in African (Negro) peoples.

Five roentgenograms.

DANIEL WILNER, M.D.
Atlantic City, N. J.

The Pseudo-Cystic Triangle in the Normal Os Calcis. Aly Sirry. Acta radiol. **36**: 516–520, December 1951.

On true lateral films of the os calcis one sees a somewhat radiolucent triangular area with its base resting on the inferior surface and its apex pointing toward the superior surface of the bone. The author studied 1,200 lateral films of the os calcis and divided the material into three groups depending upon the radiolucency of this triangular area. In the first group, representing 70.8 per cent of the cases, the area did not show well; in the second group, comprising 22.1 per cent of the cases, the area was seen moderately well; in the third group, 7.1 per cent of cases, it was clearly visualized and might have easily been mistaken for a bone cyst.

The differential diagnosis is summarized succinctly: The pseudo-cystic triangle may be differentiated (1) from simple bone cyst by the absence of bone expansion, of expansion of the cortex, of fracture, of a history of trauma, and of multiloculation; (2) from fibrosis of bone in that the cortex of the bone is neither thinned nor expanded and the bone never becomes bowed or fractured; the picture is not that of a fibrous mass in bone; (3) from osteitis deformans in that the trabeculations are regular and not coarse and there are no symptoms; (4) from medullary ecchondroma by the presence of normal bone lamellation and the absence of secondary bone changes and liquefaction; (5) from an arthritic cyst, in that it is not in relation to a joint; (6) from hydatid cyst by the absence of caseous debris, soft-tissue changes, or fractures, and by the intact lamellation and periosteum; (7) from chronic fibrous osteomyelitis by the absence of a reactive capsule of bone sclerosis surrounding the area of bone translucency and by the presence of normal lamellation in the area.

Four roentgenograms; 2 photographs.

JULIAN O. SALIK, M.D.
Baltimore, Md.

GYNECOLOGY AND OBSTETRICS

Roentgen Diagnosis of Tuberculous Endometritis. Kristina Ekengren and Åke B. V. Rydén. Acta radiol. **36**: 485–494, December 1951.

In tuberculosis of the female genital organs the most common complaint is sterility. About 10 per cent of all sterility cases are due to this cause. Numerous authors are quoted, according to whom tuberculous salpingitis shows a characteristic roentgen pattern on hysterosalpingography.

The present authors undertook to study the roentgen pattern seen in tuberculous endometritis and to ascertain whether a characteristic and pathognomonic picture could be obtained. Sixty-one women with proved tuberculous endometritis were examined on one or more occasions between the years 1940 and 1950. Only 12 showed an abnormal pattern (isthmus and cervix are not discussed in this paper). They were divided into four groups, depending on the roentgen features:

Type 1: Polyps or a polypous endometrium (4 cases). This pattern is not typical of tuberculous endometritis.

Type 2: Jagged contours, saw-toothed without strictures (4 cases). This finding might indicate the presence of tuberculosis, but is not definitely diagnostic.

Type 3: Fistulae with absence of strictures (1 case). Internal endometriosis has to be considered in the differential diagnosis.

Type 4: Strictures in the uterine cavity with fistulae extending into the myometrium (4 cases). This pattern is characteristic of tuberculous endometritis.

The authors conclude that the roentgen findings in tuberculous salpingitis are more characteristic than those encountered in endometritis, and that the latter impression cannot be sustained without knowledge of the presence of coexisting or antecedent tuberculous salpingitis. Typical roentgen findings produced by tuberculous endometritis were seen only in rare instances, in cases where the infection of the uterus was of long standing and slowly healing. A hysterogram suggestive of tuberculous endometritis is of value only if corroborated by a salpingogram indicating the presence of tuberculous salpingitis.

Twenty-two roentgenograms.

JULIAN O. SALIK, M.D.
Baltimore, Md.

Oil Embolism Complicating Hysterosalpingography. Nathan Karshmer and William Stein. J. M. Soc. New Jersey **48**: 496–499, November 1951.

Injection of iodized oil for hysterosalpingography is attended by less danger than tubal air insufflation. In several large series the frequency of oil embolization ranged from 0.4 to 1.8 per cent. Various reasons have been given for this complication: The most likely are: (1) direct trauma from the cannula; (2) injection at excessively high pressure; (3) injection when the endo-

metrium is physiologically deficient, as during menstruation or during the first six to eight days after the cessation of the menstrual period; (4) injection when the endometrium and cervix uteri have recently been subjected to surgical trauma; (5) unusual permeability of the endometrial tissue. This latter cause is suggested by the observation of cases in which repeated embolism has followed a second or third attempt at hysterosalpingography with iodized oil.

When accidental intravasation has occurred, the episode usually terminates uneventfully. The most frequent complaint is a "constricted feeling of the chest," usually immediately after the injection of the oil. Nausea with or without vomiting is common. The patient may feel chilled. The usual picture is that of a severe coughing spell either during the injection or after the patient descends from the x-ray table. This may be followed immediately or several hours later by further coughing and expectoration of bloody sputum. Pulmonary embolism may occur immediately or subsequently and may be accompanied by a moderate amount of pleural effusion. Several days later there may be a mild cerebral reaction. Any or all of these manifestations may occur with or without leukocytosis. Most cases run a favorable course, terminating in six to eight days in complete resolution of whatever damage may have occurred. The best thing to do is to keep the patient at complete rest for several hours. She is then permitted to get up and move about cautiously. Many of these patients have been allowed to go home without untoward effect. Such patients should be put to bed immediately and films should be taken of the abdomen and chest. The patient is treated expectantly until all signs and symptoms have cleared.

Diagnosis is usually made on the roentgen demonstration of opaque material in the uterine and/or ovarian veins, as well as visualization of the venous plexus of the uterus.

Pulmonary embolization is a less frequent finding unless chest films are obtained soon after the mishap. Occasionally clinical signs and symptoms may be severe enough to focus attention on this complication at once. Usually they do not become apparent for some hours or days. X-ray examination immediately points to the accident. The fractional method of injection of radiopaque iodized oil, with visualization before further serial injection, plays an important role in minimizing the danger of this unforeseen accident.

The authors report the case of a 29-year-old female in whom uterosalpingography following the fractional instillation of contrast medium into the uterus demonstrated a small amount of opaque material in the uterine vein on the left side. The patient was sent by ambulance to a local hospital and, after a few days, evidence of pulmonary embolism developed, though this appears not to have been proved. The case was previously reported (Karshmer and Stein: Am. J. Obst. & Gynec. **61**: 458, 1951. Abst. in Radiology **57**: 915, 1951.) MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Placental Calcification in the Roentgen Pregnancy Study. Joseph F. Linsman and Jack I. Chalek. Am. J. Roentgenol. **67**: 267–272, February 1952.

The presence of calcification in the placenta is a distinct aid in its localization in direct placentography. In 100 consecutive patients studied in the last four weeks of pregnancy, the authors were able to identify placental calcification unequivocally in 34 per cent. The lateral view was the most important one for detection of this finding, since in most cases the placenta lay on the anterior or posterior uterine wall. The calcification was patchy, diffusely punctate, or lace-like in appearance. The quantity of calcium varied from barely perceptible to rather extensive amounts.

Reported studies have shown that placental calcification is present in areas where the villi have degenerated and that the parts of the villi chiefly involved are those nearest the maternal surface, that is, farthest from the fetal blood supply. During the last two months of pregnancy there is depletion of maternal calcium stores in appreciable amounts, and it is at this time that the placenta contains the most calcium. Patients who supplement their diet with calcium and vitamins and who drink large amounts of milk are more apt to show placental calcification.

No unusual technical factors were used by the authors for the demonstration of placental calcification, and no special filter was employed. The film-target distance was 40 inches. For the anteroposterior view the factors were 150 ma., 68–75 kv.p., one second; for the lateral view, 200 ma., 68–75 kv.p., one-half second.

Ten roentgenograms. BERTRAM LEVIN, M.D.
Minneapolis, Minn.

Roentgen Doses During Gynecological Roentgen Diagnostic Procedures. W. Möbius. Fortschr. a. d. Geb. d. Röntgenstrahlen **75**: 734–739, December 1951. (In German)

The writer has endeavored to determine the roentgen doses that the ovaries and the fetus receive during a gynecological roentgen examination, by making measurements within the patient herself. For the routine demonstration of the fetus, he uses three exposures: an anteroposterior view, a lateral view, and an axial view. The last is taken in an almost sitting position, so that the inlet into the pelvis is nearly parallel to the film. For the measurement of the x-ray doses, a measuring device called a "Kondiometer" was used. Small button-like chambers, about 15 mm. in diameter, charged by means of the Kondiometer, were wrapped in small rubber finger cots and inserted high up into the rectum, so that they were as close to the ovaries and to the fetus as possible. The exposure was then made, the extent of the discharge of these chambers was measured with the Kondiometer, and, by means of tables, the roentgen doses received could be directly read in roentgens.

On 26 patients measurements were made during the anteroposterior exposure. The films were taken with a target-film distance of 100 cm. The kilovoltage ranged from 81 to 86 kv., and the exposure time was from four to six seconds, at 100 ma. The average roentgen dose, measured within the rectum, was 0.29333 r.

On 35 patients measurements were made during the lateral exposure. The films were taken with a kilovoltage of between 81 and 84. The time factor was from four to six seconds, using a tube current of 100 ma. The distance, however, was reduced to 70 cm. The average of the 35 measurements was 0.95748 r as measured within the rectum.

On 13 patients measurements were made during the

exposure in the sitting position. Again, the target-film distance was 100 cm., and the exposure factors were similar to those with the anteroposterior views. The average measurement obtained within the rectum was 0.12925 r. The doses received on the surface of the skin varied between 6 and 8 r.

Ionizing rays may damage the egg-cells in two respects. They may produce changes in chromosomes (abnormal union of chromosomes, breaks in the chromosomes, or separations of parts of the chromosomes) or they may produce true mutations of the genes. The chromosome changes may lead to a diminution in fertility or, if a pregnancy has occurred, may result in developmental disturbances of the fetus, particularly if the action of the ionizing rays has occurred in the early stages of gestation. The true gene mutations represent a recessive trait. They can become manifest only in the third generation if a copulation of two individuals with such recessive mutations has occurred. True gene mutations are possible with a small quantum of ionizing rays, if it so happens that the ionization occurs in the area of the genes of an egg-cell which is later fertilized. The probability is not very great, but the possibility of a hit is there, even with a small quantity of radiation.

The author recommends, therefore, that diagnostic procedures during pregnancy be reduced to the very minimum. He does not advocate the use of stereoscopic views, which would require a double dose of x-rays. The three standard views recommended produce an irradiation of only a little more than 1 r within the fetus and are, therefore, not likely to cause any permanent changes.

[The x-ray doses, as measured by the author, seem to be considerably lower than those obtained from the charts and tables presented by Ritter, Warren and Pendergrass in their recent article in RADIOLOGY **59**: 238–251, August 1952.—W.A.M.]

Three roentgenograms; 1 drawing; 3 tables.

WM. A. MARSHALL, M.D.
Chicago, Ill.

THE GENITOURINARY SYSTEM

Differential Diagnosis Between Renal Tumors and Cysts. William L. Ainsworth and Samuel A. Vest. J. Urol. **66**: 740–749, December 1951.

This article deals with the differential diagnosis between renal cortical tumors and large solitary renal cysts. Most renal cysts of this type are asymptomatic and are discovered inadvertently during a roentgenographic examination. Contrary to general opinion, large simple cysts of the kidney can be suspected from the roentgen observations, history, and physical findings; they should not be confused with carcinoma. It is neither necessary nor desirable to remove surgically most so-called solitary cysts of the kidney.

First, a urogram should be obtained. The extent of the deformity in the calices and pelvis depends on the position and size of the cyst. When urography shows a relatively small amount of cortex to be non-functioning, as is usually the case with a simple cyst, and there are no symptoms, conservative management is indicated.

With the object of avoiding operation, the authors have resorted to a simple office procedure, which is painless and harmless, to confirm the diagnosis of a simple cyst. This consists in obtaining a renal cystogram. A lumbar puncture needle is inserted through the patient's back into the cyst. Fluid is then withdrawn and a contrast medium instilled. With a simple cyst, the renal cystogram shows a generally smooth outline without any evidence of a solid tumor. As a precaution against the remote possibility of concomitant malignant tumor the fluid is studied by the Papanicolaou method.

It is the authors' considered judgment that the procedure which they have followed in the diagnosis and management of solitary cyst of the kidney has proved to be more conservative and sensible than routine exploration. They emphasize, however, that they have selected their cases with care and have used this technic only when they have strongly suspected cysts to be present. In some instances in which the cyst was small and situated in the center or hilar region of the kidney, they have carried out exploration rather than chance the insertion of a needle into a centrally located solid tumor.

Seventeen roentgenograms.

RICHARD V. WILSON, M.D.
University of Pennsylvania

The Roentgen Reticular Appearance of the Perirenal Fat Tissue in Extraperitoneal Pneumoabdomen (Retropneumoperitoneum) and Tomography. Luigi Vespignani. Acta radiol. **36**: 509–515, December 1951.

The author discusses the roentgen appearance caused by the perirenal fat as seen on tomographs following an extraperitoneal pneumoabdomen (retropneumoperitoneum), an examination which should be carried out in the anteroposterior and lateral positions as it is helpful in determining the presence and size of renal masses. A reticular formation is frequently seen surrounding radiolucent polygonal or ovoid areolae, either superimposed upon the renal shadow or located around its borders. The explanation for this finding, as given by the author, is that the connective fibers of the fatty tissues are represented by the strands of the "roentgenological reticulum" and that the clear polygonal spaces are produced by the fat lobules and also by gas which has infiltrated between the connective tissues. This pattern is normal and should not be misinterpreted as indicating perinephritis.

Five roentgenograms; 1 drawing.

JULIAN O. SALIK, M.D.
Baltimore, Md.

Multiple Prostatic and Urethral Calculi Resulting from Urogenital Tuberculosis. Roentgen Differential Diagnosis of Prostatic Concretions. Gustaf Notter. Acta radiol. **36**: 495–508, December 1951. (In German)

The author reports the case of a sixty-four-year-old male who had an epididymitis in 1916 and a nephrectomy in 1924 because of tuberculosis; in addition, a diagnosis of pulmonary tuberculosis was made. About twenty-five years later the patient complained of painful micturition, and on the films a conglomerate of calcifications, 4 × 4 cm., was seen in the region of the prostate. On subsequent urethrograms a cavity with smooth borders containing calcifications was noted. The stones were analyzed and identified as calcium triphosphate and calcium carbonate. They are believed to have been formed from a tuberculous focus. The author discusses in detail the etiology,

classification, symptoms, differential diagnosis, and treatment of prostatic calcifications.

Twelve roentgenograms; 1 photograph.

JULIAN O. SALIK, M.D.
Baltimore, Md.

Scrotal Cystocele. Bernard Levine. J.A.M.A. **147:** 1439–1441, Dec. 8, 1951.

The author adds 2 cases of scrotal cystocele to the 30 cases previously recorded in the literature and briefly reviews the contributions of others dealing with this condition. His first patient was a 57-year-old man who had had two bouts of hematuria and one attack of left renal colic in the preceding three months. Excretory urography prior to hospital admission had shown bilateral hydronephrosis and delayed renal function, with displacement of the bladder to the right side of the pelvis. A right scrotal hernia of moderate size was obvious upon physical examination. Residual urine was 10 c.c., but pressure upon the hernia resulted in withdrawal of 150 c.c. of additional residual urine. A retrograde cystogram showed the pelvic portion of the bladder to be drawn to the left side, and the major part in the inguinal and scrotal regions. Surgical repair was successful.

The second patient was an 81-year-old man who complained of dysuria and gave a history of bladder stones. He also had a right inguinal hernia. Cystography revealed a scrotal cystocele. Operation was deferred because of the patient's age and general condition. Subsequently resection of the herniated bladder was undertaken elsewhere, but death occurred postoperatively.

The treatment recommended by the author is replacement of the unopened bladder and hernioplasty in cases suitable for surgery.

Two roentgenograms. SIDNEY KING, M.D.
Hancock, Mich.

THE BLOOD VESSELS

Translumbar Arteriography: Its Roentgenologic Interpretation. Parke G. Smith, Arthur T. Evans, Edward C. Elsey, and Benjamin Felson. Am. J. Roentgenol. **67:** 183–196, February 1952.

The authors have performed some 800 translumbar aortic punctures with no significant complications. They describe briefly the technic of puncture, injection of the contrast medium and radiography, but their main concern here is with interpretation of the arteriograms. The report is based upon 200 selected arteriograms obtained on 175 patients, ranging in age from eleven to eighty-one years. There were 50 normal and 120 abnormal arteriograms; the remaining 30 were considered unsatisfactory for technical reasons. The examinations were done under general anesthesia with the patient in the prone position.

The authors discuss the normal arteriogram at great length and illustrate the normal renal arterial pattern, the celiac artery and its branches, the superior and inferior mesenteric arteries and their branches, and the normal nephrogram.

Among the abnormal conditions which are discussed and illustrated with roentgenograms are: renal anomalies, including anomalous renal artery, congenital malposition, horseshoe kidney, renal duplication, and renal hypoplasia and agenesis; impaired renal circulation occurring for the most part in hydronephrosis and/or infection with severe renal damage, in which cases the arteriogram may help decide for or against a nephrectomy; arterial disease, including aneurysm of the aorta or other large vessels, arterial thrombosis, and renal infarctions; abdominal masses, including renal tumors, solitary renal cyst, polycystic kidneys, and enlarged spleen. Arteriography was also done in 5 pregnant patients but was unsatisfactory in 2; in 1 case a suspected placenta praevia was ruled out by the procedure.

In many cases arteriograms offered vauable preoperative information not obtainable by other means.

In 10 cases the contrast medium was accidentally injected into a branch of the aorta, the renal, celiac, superior mesenteric, or inferior mesenteric artery. No harmful sequelae developed, but the authors know of 3 cases in which direct injection of the superior mesenteric artery resulted in mesenteric infarction and death. This can be avoided by puncturing the aorta at a high level, above the origin of the celiac plexus. The level of the twelfth thoracic vertebra is recommended.

Thirty-six patients had arteriograms made four hours to twenty-four days before death. All were moribund because of malignant neoplasms or other disease. Each was studied at autopsy. In 6 some evidence of blood outside the aorta was present, but in no instance was the amount significant.

The only contraindications to arteriography which the authors have heeded have been iodine sensitivity and uremia. Old age, arteriosclerosis, and hypertension have not been regarded as serious risks. At the present time the procedure is believed to be of definite value in the diagnosis of arterial obstruction, aneurysm of the abdominal aorta or its branches, and left upper quadrant abdominal masses. It is also of aid in the diagnosis of anomalous renal artery, and in the determination of the portion of the kidney supplied by the aberrant vessel. In addition, arteriography is the best means of obtaining preoperative information about the non-functioning kidney with impassable ureteral obstruction. Further experience, they believe, will substantiate that arteriography is useful in the differentiation between renal cancer and cyst, in the demonstration of placenta previa, and in determining the indications for nephrectomy in cases of severe hydronephrosis and/or infection.

Seventeen arteriograms are shown.

BERTRAM LEVIN, M.D.
Minneapolis, Minn.

Present Status of the Radiologic Exploration of the Aorta and Its Branches. A. Castellanos, R. Pereiras, O. García, J. M. Viamonte, R. Hernández Beguerie, J. Centurión, E. González Peña, D. García Núñez, Lino Boudet, R. Bustamante, E. Pérez Stable, R. Guerra, B. Milanés, and R. Casanova. Rev. cubana cardiol. **11:**1–124, 1950. (In Spanish)

This symposium on aortography arranged by the first two authors for a joint session of the Cuban societies of cardiology and radiology, March 22, 1950, appeared in two successive issues of the Cuban Review of Cardiology, and was reissued as a single reprint. It is much too lengthy for an ordinary abstract.

The evolution of aortography is fully discussed (30 pages), including the important pioneering done by the Cuban school under the leadership of Castel-

lanos and Pereiras. A section of 25 pages is devoted to aortography of the thoracic aorta and its branches by levoangiocardiography, in the adult. Retrograde superior aortography, *via* the common carotid artery, in children and in adults is next considered. Then comes a description of opacification of the thoracic aorta by catheterization of the humeral artery (30 pages), and finally a short section on the radiologic study of the abdominal aorta and its branches.

All of the above communications are presented in an authoritative manner consistent with the leadership and extreme ingenuity of the authors and their collaborators, who have won universal acclaim in angiocardiographic and radiologic practice. This document is worth a place in every medical library.

JAMES T. CASE, M.D.
Santa Barbara, Calif.

Aortography: Its Interpretation and Value. A Report of 200 Cases. René Leriche, Peter Beaconsfield, and Colette Boëly. Surg., Gynec & Obst. **94:** 83–90, January 1952.

The authors review their experience with a group of 200 patients in whom aortography was performed. The series included 175 cases of obliterative arteritis of different types, and these are more thoroughly discussed.

Aortography is employed only after simpler methods fail to give the necessary information for the best management of the patients. The indications, contraindications, and technic are reviewed. To obtain a better concentration of the 70 per cent diodrast, two needles are introduced into the aorta. The authors do not recommend retrograde catheterization in arteries of patients with peripheral vascular diseases.

In *thromboangiitis obliterans*, aortography shows an intact arterial wall and very few, if any, collaterals. The circulation of the main trunk is not re-established below the lesion and there is a generalized peripheral vasospasm. The authors have obtained aortograms in 56 cases, but they feel that the procedure is seldom indicated. It does not give any indication as to prognosis and is of no help in determining therapy, since reconstructive surgery has thus far proved unsuccessful.

In *arteriosclerosis obliterans* (including the atheromatous and the Mönckeberg types), the aortograms show increase in the diameter of the vessels and their tortuosity, obliterations, and the degree of collateral circulation, with the possibility of filling of the main arterial trunk below the site of obliteration.

Aortography was useful as furnishing indications for operation in this group. In 36.1 per cent of 83 patients, arteriectomy was done after aortography had revealed marked stenosis of the artery without complete obliteration. Arteriectomy is much more effective for relief of pain in these patients than sympathectomy alone. If grafting is to be done, aortography is also of help in showing the extent of the obliterated zone to be grafted.

Mixed arteritis may be described histologically as a segmental endarteritis obliterans with proliferation of the intima but without true atheromatous changes. There were 22 patients in this group, and the frequency of surgical interventions over the arteries (22.7 per cent had arterial grafts, 31.8 per cent arteriectomy, and 0.9 per cent debouchage) favors a good localization of the lesions as obtained in the aortograms.

In *endarteritis of the bifurcation of the aorta*, producing the clinical entity known as the Leriche syndrome, aortography is the only method of confirming the diagnosis, which is important, since the prognosis after bilateral lumbar sympathectomy is favorable.

The remaining 25 cases in the authors' series include, among others, aneurysms, where localization of the lesion is of great help to the surgeon; also arteriovenous fistulas and embolism, but the latter may be located by physical examination.

As can be seen, aortography is of value for indicating treatment and prognosis, as it gives the exact location, extent of the lesion, and condition of the arterial wall.

Nine roentgenograms; 1 table.

FRANCISCO CAMPOY, M.D.
University of Pennsylvania

Direct and Retrograde Aortography. Ralph A. Deterling, Jr. Surgery **31:** 88–114, January 1952.

The author has successfully employed the Wagner modification of the dos Santos technic for direct translumbar aortography (J. Urol. **56:** 625, 1946; Surg., Gynec. & Obst. **84:** 619, 1947; Am. J. Roentgenol. **58:** 591, 1947. Abst. in Radiology **49:** 524, 1947; **50:** 276, 1948; **51:** 445, 1948), making use of Pentothal Sodium anesthesia and injection of sodium iodide by hand syringe. At present, however, he sees greater advantages and safety in a technic employing local anesthesia and an organic iodide. Among 55 patients studied by the Surgical Service and over 40 by the Urological Service, Presbyterian Hospital, New York City, there were no fatalities. Transient encephalopathy was noted in 2 patients and chemical neuritis in 3, all of whom received 80 per cent sodium iodide.

Retrograde abdominal aortography appears to have no advantages over the translumbar method and there are definite practical disadvantages.

In visualizing the thoracic aorta, the direct approach has been far less popular or successful than the retrograde route. The organic iodide compounds have been most satisfactory, being injected *via* needle or catheter introduced into the arteries of the upper extremity or the common carotid artery. Poor visualization and one related fatality were experienced in 3 cases in which iodopyracet (Diodrast) was injected through a catheter into the thoracic aorta *via* the ulnar artery. Excellent visualization but two serious complications resulted from the use of a catheter in the left common carotid artery in 12 patients.

Experimental studies in dogs, and some of the cases in human beings, indicated a consistent pattern of vasomotor response to intra-aortic injection of four different contrast media. There was a considerable difference in the degree of the cardiovascular effects with the various agents tested, sodium iodide causing the greatest changes.

Seventeen figures, with 14 roentgenograms.

Technic and Indications for Lumbar Aortography. E. Gadermann and E. A. Schrader. Fortschr. a. d. Geb. d. Röntgenstrahlen **75:** 670–678, December 1951. (In German)

The authors describe the technic of lumbar aortography as follows: Preparation consists in administration of an enema and, in the case of very nervous patients, a sedative. No anesthesia is used. The puncture of the aorta is carried out by means of two needles,

equipped with a mandrin, similar to a spinal puncture needle, about 14 to 16 cm. long with an external circumference of 1.2 mm. [This latter figure is undoubtedly an error; it should probably read *diameter*.—W.A.M.]. With the patient prone upon the x-ray table, the needles are inserted below the twelfth rib on the left side about four fingers laterally from the spinous processes. The needle is directed cranialward and slightly medialward and pushed forward until it strikes the aorta. If the needle strikes the transverse process or the body of a vertebra, its direction is slightly altered. The location of the needle in the aorta is recognized by pulling out the mandrin, whereupon a strong arterial pulsation is observed. After one of the needles has been inserted, the second one is placed close to it and injection is usually made into both needles. Only if the aorta cannot be found with one of the needles is the injection carried out with a single needle. When the needle is directed cranialward, it usually pierces the aorta above the origin of the renal artery and the kidneys are visualized. If, however, kidney visualization is not desired, the needle is inserted perpendicularly to the aorta.

The injection apparatus consists of a 50-c.c. syringe firmly attached to a stand in a vertical position. The piston of the syringe has a large handle; the tip is connected to the two needles by means of a rubber hose about 70 cm. long, divided near the end into two branches, each leading into one of the needles. This apparatus permits the injection to be made with great force. Fifty cubic centimeters of the contrast medium can be injected within two to four seconds. As the exposure time is about two seconds, exposure is begun as soon as 10 c.c. of the contrast medium has been injected. In this way maximal filling of the vessel will be shown. After the exposure, the rubber hose is removed from the needles and the mandrins are reinserted until the film has been developed. If a satisfactory film is obtained, the needles are removed and the patient is allowed to get up at once and walk about. All of the patients on whom the procedure was done were ambulatory and went home. The contrast medium is water-soluble Umbradil, 70 per cent (Astra). In order to test for hypersensitivity an injection of 2 c.c. is given before the procedure.

In one of the cases the needle was apparently pulled out of the aorta by accident, and the contrast medium spread along the vessel within the tissue up into the thorax, with no serious effect. In another case the needle apparently struck the aorta tangentially and the contrast medium was injected into the wall of the vessel. The wall infiltration can be plainly seen on one of the films. Again no serious sequelae followed. In order to avoid such complications, the authors inject first about 4 or 5 c.c. and then release the piston to see whether blood pulsates back into the syringe. A complication described elsewhere, but not experienced by the authors, is entering of the spinal canal through an intervertebral foramen. In this case the appearance of cerebrospinal fluid should immediately warn the operator. The injection of the contrast medium into a small vessel instead of the aorta can be prevented by moving the needle back and forth to some extent and observing the continued pulsation.

This procedure can be carried out without any difficulties even in patients with coronary disturbances and with definite degenerative myocardial changes as demonstrated on the electrocardiogram. Calcification of the aorta is no contraindication; on the contrary, a calcified aorta is less likely to ooze after puncture. The procedure is indicated in any suspected circulatory disturbance in the iliac vessels. Leriche has shown that stenoses and occlusions occur in these vessels about as frequently as in the femoral vessels.

An intravenous pyelogram can be made at the same time if necessary and, if the renal vessels are demonstrated, a partial obstruction of the ureter, perhaps through an aberrant vessel, can be shown.

Eight roentgenograms; 2 photographs; 1 drawing.

WM. A. MARSHALL, M.D.
Chicago, Ill.

Visualization of the Hepatic Veins. Giulio Tori. Reprint (pp. 1–5) from Bull. sc. med. (Bologna), Vol. 124, 1952. (In Italian)

The author reproduces roentgenograms of five normal cases in which the hepatic veins were made opaque to x-ray in an attempt to discover liver disease. The technic involves the insertion of a cardiac catheter in one of the veins of the arm and introduction of the tip of the catheter into the hepatic veins under fluoroscopic control. No difficulties were encountered in reaching the hepatic veins after passage of the catheter through the superior vena cava, the right atrium, and the inferior vena cava. The procedure was tolerated quite well, and the roentgenograms show excellent visualization of the hepatic venous system.

Since the method has not as yet been employed in pathological livers, it is difficult to tell what applications it may find. It is, however, another step in the extension of roentgen diagnosis.

Four roentgenograms.

CESARE GIANTURCO, M.D.
Urbana, Ill.

THE X-RAY DEPARTMENT; APPARATUS

The X-Ray Department in Civilian Catastrophes. Edward F. Klein and Benjamin Copleman. J. M. Soc. New Jersey **48**: 505–506, November 1951.

It is suggested that radiologists might survey their departmental situation with a view to preparedness for unexpected overloading as a result of civilian catastrophes. On May 19, 1950, there was an explosion of munitions-laden lighters in the harbor of South Amboy, N. J., and though casualties were numerous, not more than a dozen radiographic examinations were made at the two local hospitals. On Feb. 6, 1951, however, a nearby train wreck resulted in 221 patients being treated in one hospital, and within one hour after the first admission the x-ray department was overtaxed. Certain procedures on that occasion expedited the work and, on this basis, the following suggestions are offered:

(1) A priority system should be established by experienced clinicians, so that persons requiring immediate roentgen examinations receive attention first.

(2) Volunteer personnel should be adequate to handle large patient loads and should be organized in teams to handle stretchers and assist the technician. There should be frequent changing of teams to avoid excessive radiation exposure.

(3) If the load is large enough to necessitate continuous night work, extra teams of technicians and at least two radiologists are necessary.

(4) A tag may be used for an identification form,

one side being used for the wet film report and the other for the emergency report. Final formal reports are made when the films are dry.

(5) The patient should be returned to his site of origin in the hospital as soon as the wet-film reports are made.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

A New Method of Obtaining Focused Images with X-Rays. G. N. Ramachandran. Phys. Rev. **85**: 378–379, Jan. 15, 1952.

X-rays of all wave lengths from a point source falling on a cleavage plate of crystal bent to a spherical surface will be reflected to a focus-like light, but only those wave lengths satisfying the Bragg condition will be reflected, the rest being transmitted. To use a second mirror thus and make a compound x-ray microscope would require a very special relation between the two mirrors so that the selected wave length from a particular part of the first mirror would hit the second one at an angle satisfying the Bragg condition ($\lambda = 2 d \sin \theta$). The mirror settings require accuracy similar to that required in a double-crystal spectrometer. The author does not say he is going to make one.

R. R. NEWELL, M.D.
San Francisco, Calif.

Beryllium-Window Tube Outputs: Further Considerations Regarding the Use of Constant and Pulsating Tension. W. Alan Jennings. Acta radiol **36**: 477–484, December 1951.

The author discusses the theoretical approach used to compare the radiation outputs and qualities obtained by pulsating and constant potential generation of a beryllium-window tube operated over the range of 10 to 50 kv.p. He compares his data with those obtained by Braestrup, and mentions a stroboscopic device which was used, but the detailed report of this technic is not described, as it was still in a preliminary stage. The dependence of the ratio of radiation qualities between constant and pulsating tensions expressed in terms of half-value layer in aluminum was seen to rise with fall in kilovoltage but was little influenced by changes in external filtration (0.0 to 0.5 mm. Al). Similar relationships (to those for h.v.l.) were discovered to be true for the relative absorption of the beam in air under the two types of generation. The relative beam penetrations in "tissues", expressed in terms of half-value-depth (h.v.d.), were more difficult to derive from a theoretical standpoint, but the author arrived at an estimate of the relative h.v.d.'s under constant and pulsating tension and gives this estimated data in the form of a graph.

The constant potential is to be preferred, as with low kilovoltage and filtration the output is relatively greater and also it can be adequately calibrated by a thimble chamber method, whereas the wave generation by a pulsating potential does not lend itself to a reliable sustained calibration by this means. However, the size of condensers required for constant potential makes its use impracticable unless the kilovoltage is lowered. This in turn with the milliamperage used (up to 50 ma.) produces an appreciable ripple, ranging up to 100 per cent and leads to a dependence of quality on the tube current. Therefore, the existent commercial designs of low kilovoltage units fitted with beryllium-window employ pulsating tension.

Three figures; 1 table.

JULIAN O. SALIK, M.D.
Baltimore, Md.

RADIOTHERAPY

Radiation Therapy of Malignant Melanoma. Paul H. Reitman. Am. J. Roentgenol. **67**: 286–293, February 1952.

The author reports on 42 cases of malignant melanoma to show the response of this tumor to irradiation. The intent is to prove that the results have been at least as favorable as with radical surgery, while at the same time the patient is spared a mutilating operation.

In 50 to 80 per cent of cases the malignant melanoma arises from a pre-existing benign nevus, trauma being the most important single factor causing the transition from benignancy to malignancy. Because of this the author contends that biopsy is contraindicated and that the diagnosis of malignant melanoma should be made clinically. "Any pigmented lesion of the skin arising *de novo*, exhibiting unreasonable growth, pigment change, satellite formation, erosion, bleeding and/or ulceration, or any pre-existing pigmented lesion exhibiting similar changes should be considered malignant." Among the skin lesions to be considered in the differential diagnosis are keloids in children following mild trauma, seborrheic warts, pigmented papillomas, neurofibromatosis, Bowen's dermatitis, sebaceous cyst, and pigmented basal-cell and squamous-cell epitheliomas. The case history and physical examination should serve to make the diagnosis.

In the reported series, the average age was 43.3 years, with the average and mean age of the group surviving significantly lower than of the group not surviving. Four patients in the survival group ranged from five months to four years of age. There were 21 survivors and 21 deaths. The survivors, of whom one has multiple quiescent metastatic nodules, are alive for periods of three months to eight years. In this group 8 cases were diagnosed clinically and 13 by microscopic section. All cases terminating fatally were proved pathologically. In 57 per cent of the survivors the lesion was purely a local one; in only 4 per cent of the fatalities was the lesion strictly local when first treated. Thus, much of the therapy in the latter group was directed at palliation. Only 6 of the survivors had a history of trauma or previous surgery for the tumor; 15 of the non-survivors gave such a history. In only 1 case, where the primary lesion was on a toe, was the treatment amputation with a prophylactic block dissection of the inguinal lymph nodes. In the other cases surgically treated there was local excision combined, in some instances, with block dissection of the regional lymph nodes. In 52 per cent of the cases the lesion was in the lower extremities.

The author believes that the effective cancerocidal dose for malignant melanoma lies between 5,000 and 8,000 gamma roentgens. For larger fields he prefers about 7,000 and for smaller areas 8,000 gamma roentgens. This high dose has been achieved over single fields by the use of radium element. A surface plaque was used for small localized lesions and a 4-gram radium "bomb" was used for the irradiation of larger areas and

for metastatic regional lymph nodes. Roentgen radiation was not used since the corresponding dose range is disproportionately too severe and fractionation and protraction are more easily achieved with radium therapy.

Of the 21 survivors, 9 were treated by irradiation alone; 7 had preoperative irradiation, 7 postoperative irradiation (2 both preoperative and postoperative irradiation). One patient received irradiation alone to new metastatic areas and postoperative irradiation to areas previously excised.

A number of case histories are given, including one of a male who survived twelve years and eight months following diagnosis and treatment (surgery) of malignant melanoma but finally succumbed to the disease.

Two charts.

BERTRAM LEVIN, M.D.
Minneapolis, Minn.

Radiation Treatment of Carcinoma of the Breast. E. Berven. Fortschr. a. d. Geb. d. Röntgenstrahlen **75:** 10–25, (Sonderheft) December 1951. (In German)

In spite of recent progress in operative technic, improvement of radiation therapy and the use of hormones and chemotherapy, the results in breast carcinoma have shown no marked improvement. Seventy per cent of the patients die with local recurrence or metastatic disease within the first five years. About half of the cases observed in a large clinic were practically inoperable at the first consultation. The author particularly stresses the difficulty in statistical appraisal because of the lack of uniformity in classifying the material. He feels that public education, especially in regard to the early recognition of any tissue thickening or lump in the breast, is of the greatest importance.

The initial operation, if performed for diagnosis, should be radical enough to remove all palpable disease; if cancer is found, the complete operation should be performed as soon as possible. Those cases handled exclusively by radical operation have shown in the various large clinics approximately 30 per cent survival at five years, including all stages.

There are four types of combined procedure: (*a*) preoperative irradiation, radical operation, and postoperative irradiation, (*b*) primary radical operation and postoperative x-irradiation, (*c*) primary radical operation and postoperative radium treatment, (*d*) simple breast amputation with postoperative irradiation by x-rays or radium.

Preoperative irradiation is given through the breast and to the anterior and posterior supraclavicular and the axillary areas. Technical factors are 180 kv., 0.5 mm. Cu and 1.0 mm. Al filtration (h.v.l. 0.75 mm. Cu), 40 to 50 cm. target-skin distance. Daily treatments are given, of 350 r (measured on the skin). Four to five treatments are given over each field and the tumor dose is estimated as 2,000 r within the breast and 1,500 r in the axilla. A light erythema appears and resolves in approximately three weeks.

Postoperative therapy is commenced ten days after operation. Similar fields are used, and the series is repeated in two months and occasionally again after three months. The author states that heavier doses and reactions produce no better results than the more conservative type of therapy.

In Cases of Stage I with preoperative and postoperative irradiation the author reports 68 per cent five-year survivals, and in Stage II, 44 per cent five-year survivals. In Stage I cases irradiated postoperatively only, the five-year survival rate was 66 per cent; for Stage II cases it was 40 per cent.

Preoperative irradiation appears to be definitely indicated, contributing to better healing because of the influence on the "tumor bed." It also supplies information as to the sensitiveness of the tumor and its reaction to radiation, which may influence the future method of handling the case. In Stage I, preoperative irradiation probably gives no better results than postoperative therapy, but in Stage II with node involvement there was five-year freedom from disease in 32 per cent of those treated both before and after operation against 7 per cent among the group receiving postoperative irradiation only. Since it is often impossible to differentiate accurately between Stages I and II, it is probably wise to give the patient the advantage of irradiation in all cases.

The objections to preoperative irradiation have been as follows: (1) Operation is sometimes postponed by the patient with consequent risk of spread of the disease. If surgery is done within one month after irradiation, danger of spreading is minimized or completely obliterated. (2) Radiation may contribute to bleeding and difficult operation. This has not been the experience of the author. (3) A sensitive tumor may disappear and operation will not be done. Operation should be carried out even though the tumor may have completely disappeared. (4) Preoperative irradiation may cause edema of the arm. The author has found no basis for this.

It is concluded that (*a*) preoperative irradiation is conducive to the best results; (*b*) postoperative irradiation (after radical resection) gives definitely better results than surgery alone; (*c*) simple amputation followed by irradiation may be considered when the tumor is definitely known to be local or when it is totally inoperable and local removal is carried out to rid the patient of sloughing ulcer; (*d*) irradiation exclusively should be used only in definitely inoperable tumors, as a palliative procedure.

Six drawings; 1 photograph.

E. W. SPACKMAN, M.D.
Fort Worth, Texas

Radium Therapy for Cancer of the Cervix Uteri with a New Type of Colpostat. Sidney M. Silverstone, William Harris, and Maurice Greenberg. Am. J. Roentgenol. **67:** 294–299, February 1952.

The authors describe in detail a colpostat which has been used at the Mt. Sinai Hospital, New York, for three years and found to be highly satisfactory and practical. The colpostat consists of two ovoids shaped to approximate the isodose surface from a short linear source of radium and connecting rods. [For a detailed description of the apparatus the reader is referred to an earlier report in J. Mt. Sinai Hospital **14:** 369, 1947.] The ovoids are so shaped as to eliminate radiation "hot points"; the intensity at every point on the surface of the ovoid is the same, except for less intensity at the poles. The transverse diameter of the ovoid is 2 cm. and therefore the minimum distance between the vaginal mucosa in contact with the ovoid and the center of the radium is 1 cm. An ovoid is placed in each fornix under direct vision and fixed in position by connecting rods and a locking pivot. Usually the radium sources are separated by 4 cm., with a 25-mg. capsule of radium with a filtration

of 1.0 mm. of platinum in each ovoid. The radium is left in place for a total of 4,800 mg. hr.

The intra-uterine tandem used contains 40 mg. of radium, made up of one 10-mg. and two 15-mg. capsules, the weaker source being placed at the cervical end. The filtration is 1.0 mm. of platinum. The tandem is kept in place for 3,600 mg. hr.

The dose to the vaginal mucosa, where it is in contact with the ovoids, is of the order of 17,000 r; to the cervix, 12,000 r; to the paracervical triangle, 6,400 r; to the lateral parametrium, 2,000 r; to the base of the bladder, 4,500 r; to the anterior rectal wall, 4,500 r; to the head of the femur, 500 r.

The authors feel that the particular advantage of the colpostat is that the ovoids can be separated to the maximum permitted by the tissue of the vaginal vault, so that the maximum possible dose to the lateral parametria may be delivered.

Five illustrations; 2 tables.

BERTRAM LEVIN, M.D.
Minneapolis, Minn.

Carcinoma of the Uterine Cervix. Incidence and Influence of Age. A Statistical Study. Arne Lindell. Acta radiol., Suppl. 92, 1952.

In this investigation the author studied the effect of the patient's age upon various aspects of the nature and behavior of carcinoma of the uterine cervix. The stage-distribution, the duration of symptoms, the course, the prognosis and response to radiation therapy are considered, and differences are categorized and related to the age at which the disease appeared. In addition to this, the author studied the incidence of the disease in relation to age grouping.

The first part of the investigation involved a study of 5,258 cases of cervical carcinoma, and was designed to answer the question: Does the age of the patient have any significance as to the course and prognosis of carcinoma of the uterine cervix?

The second part of the study, on the relation of age to incidence of the disease, is based on the total female population of Sweden for the years 1920 to 1949, in which there were 10,863 cases of cervical carcinoma.

In 98 pages, containing 38 tables, 18 graphs, a modicum of calculus, and careful statistical analysis, the author concludes that his study indicates that:

1. The prognosis is better in older women than in young.

2. The mortality runs an evener course in the older women, with a lower rate than among the young during the first years after treatment.

3. The duration of symptoms is generally longer in the older women.

In short, his findings would indicate that carcinoma of the uterine cervix is less malignant in the elderly than in the young.

The morbidity rate was highest between the ages of fifty-one and fifty-five, and has been rising in this age group. If the rise in incidence of cervical carcinoma continues, and assuming that it reaches the Danish rate for the years 1942 to 1944, by 1965 the number of cases of carcinoma of the cervix in Sweden would reach 1,100 annually. This compares with 600 cases in 1949, or almost double. This increase would have far-reaching consequences for the organization of the gynecological cancer service in Sweden.

SIDNEY KING, M.D.
Hancock, Mich.

Treatment of Angiomas: Summary of Twenty Years' Experience at Columbia Presbyterian Medical Center. George C. Andrews, Anthony N. Domonkos, and Charles F. Post. Am. J. Roentgenol. 67: 273–284, February 1952.

This report is based on experience with 1,239 hemangiomas over a period of twenty years. Nevus flammeus and nevus araneus accounted for 321 cases and there were 892 cases of hemangioma simplex or cavernosum. Six hundred and two of the patients were one year of age or younger. The lesions were on the head in 60 per cent of the cases.

Though it is common for hemangiomas to disappear spontaneously, it is also common for them to grow, ulcerate, destroy soft tissue, and form disfiguring scars. The authors note that "it is important that doctors learn that angiomas are very easy to treat when they are first noticed and that it is unwise to wait for them to disappear spontaneously. It is much safer to treat them effectively at once and thus prevent all danger of their growing larger, ulcerating and seriously threatening the child with disfigurement."

The majority of hemangiomas in this series were treated with radium plaques. Full-strength plaques (5 mg. per square centimeter) with 2 mm. of brass filtration are kept on the skin for three and a half hours. One or more plaques may be used, depending on the size of the angioma. The plaque is tightly applied to the lesion so as to force out as much blood as possible. One, two, three, or four treatments are given as needed. No more than four treatments are given, with intervals of at least three months between treatments. "Rarely, some remnant may persist after four treatments. This will disappear in time."

For treatment of some bulky hemangiomas, radium plaques at a distance of 11.5 mm. are used. The filtration is equivalent to 2 mm. of brass.

In the past ten years treatment with the described technics have given excellent cosmetic results without atrophy of the skin or other sequelae in all cases of simple or cavernous hemangioma. Scarring was frequently seen from previous carbon dioxide treatment and after treatment of crusted or ulcerated lesions.

The radium dosage used is safe at any age, and no injury to the eye has been experienced. However, because of the criticism of the use of radium near the eyes, it is usually simpler to treat such angiomas by injections of sclerosing solutions.

Some hemangiomas have been treated with superficial or contact roentgen radiation but, though there have been excellent results, treatment with gamma-ray plaques has been more suited to the physical requirements.

In cases where there is evidence of infection (crusting, tenderness, ulceration) the patient should first be treated with penicillin until the infection clears.

A large number of cases were treated by injection of sclerosing solutions. This method of treatment is of particular value in the management of angiomas around the eyes or of the eyelids. The cosmetic results are not as good as with radium treatment.

Refrigeration with solid carbon dioxide and surgical excision were used in a comparatively small number of cases.

Thirty-six photographs; 1 table.

BERTRAM LEVIN, M.D.
Minneapolis, Minn.

Intensive Roentgen Irradiation of Advanced Cancer Through a Lead Rubber Sieve. (Experience During a Year with 140 Cases). Ch. Botstein and W. Harris. Fortschr. a. d. Geb. d. Röntgenstrahlen **75:** 26–39, (Sonderheft) December 1951. (In German)

This is an account in German of the experience with grid therapy in advanced cancer as carried out at Mt. Sinai Hospital, New York. See papers by Marks Harris, and Loevinger, in Radiology **58:** 338, 343, 351, 1952, as well as an Editorial on the subject in Radiology **58:** 424, 1952.

Fourteen illustrations.

RADIOISOTOPES

The Iodine-Deficient Human Thyroid Gland. A Preliminary Report. John B. Stanbury, Gordon L. Brownell, Douglas S. Riggs, Hector Perinetti, Enrique del Castillo, and Juan Itoiz, with the assistance of Alberto Houssay, Eduardo Trucco, and Armando C. Yaciofano. J. Clin. Endocrinol. & Metab. **12:** 191–207, February 1952.

The iodine-deficient thyroid gland is characterized by its avidity for iodide. In a series of 118 clinically euthyroid patients in Mendoza, Argentina, an area of iodine deficiency, a wide variation in I^{131} uptake was found, with many values over 60 per cent of the administered dose within forty-eight hours. A relationship was observed between the daily excretion of I^{127} and I^{131} accumulation.

The rate of accumulation of I^{131} in the thyroids of iodine-deficient patients was rapid and the apparent rate of release was slow. When an effective thyroid-blocking drug (1-methyl-2-mercapto-imidazole) was given, however, the slope of the retention curve of labeled iodine became much greater, indicating a rapid rate of turnover for the I^{131}. There was a further increase in rate of iodine release when thyrotropin was given. This change indicated that these thyroid glands were not under maximal stimulation from endogenous thyrotropin.

Daily dietary supplements of I^{127} were remarkably ineffective in reducing the I^{131} accumulation, but exogenous thyroid depressed the uptake in most of the patients to whom it was given.

Eight illustrations.

A Study of the Mechanism of the Inhibition of the Thyroid Gland Induced by Ingestion of Thyroid Substance. Martin Perlmutter, Shirley Weisenfeld, Stanley Slater, and Eleanor Z. Wallace, with the technical assistance of Maxima M. David. J. Clin. Endocrinol. & Metab. **12:** 208–227, February 1952.

The effect of the intramuscular administration of varying doses of the thyroid-stimulating hormone (TSH) of the pituitary gland upon the function of the thyroid was studied in 18 normal subjects. Ten milligrams of TSH was found to be the dose minimally effective in increasing the uptake of I^{131} by the thyroid and the level of the serum protein-bound iodine (PBI), which have proved to be the most sensitive indices of thyroid function.

The ingestion of 120 mg. of thyroid substance daily for twelve or more days resulted in a decrease in the thyroid uptake of I^{131} to hypothyroid levels, unaccompanied by any increase in the level of the serum PBI and with only a slight increase in the basal metabolic rate.

Both the serum PBI level and the mean uptake of I^{131} by the thyroid gland which had been inhibited by ingestion of thyroid substance could be increased to hyperthyroid levels by the administration of 10 mg. or 60 mg. of TSH.

After similar doses of TSH, the increment in the uptake of I^{131} by the thyroid gland which had been inhibited by ingestion of thyroid substance was greater than the increment in uptake in the control studies. The total collection of I^{131} in the former case, however, was less than the total uptake in the latter. Both the increase in, and the highest levels reached by, the serum PBI in response to TSH injections were the same in the control and in the thyroid-inhibited periods.

Rebound hypofunction of the thyroid gland was noted fourteen days following an injection of 60 mg. of TSH. Rebound hypothyroidism was not noted following the administration of 10 mg. of TSH.

A second dose of TSH administered during the rebound phase evoked not only a greater increment in, but also a greater total collection of I^{131} than had been noted following the original dose of TSH. The increase in the level of serum PBI was the same after each of the two injections of TSH.

The authors' data lend support to the view that ingestion of thyroid substance decreases the function of the thyroid gland primarily through pituitary inhibition. To a minor degree, the ingested thyroid substance appears to decrease the responsiveness of the thyroid gland to administered TSH.

Two charts; 10 tables.

Effect of Destruction of Thyroid Glands by Radioactive Iodine on Pancreatic Diabetes in the Dog. William B. Neal, Jr., Lester R. Dragstedt, Georgiana R. Rogers, and Gordon McKeague. Am. J. Physiol. **168:** 29–32, Jan. 1, 1952.

Six dogs were given subcutaneous injections of I^{131} in doses of 0.5 to 1.0 mc. per kilogram, an amount sufficient to cause almost total destruction of the thyroid gland in six to eight weeks. Two of the animals had previously been subjected to total pancreatectomy, and a third to partial pancreatectomy and ligation of the pancreatic ducts. Diabetic dogs were given insulin twice daily in amounts adequate to control glycosuria.

A hyperlipemia and hypercholesterolemia developed in the normal dogs given I^{131}. Liver function, as judged by needle biopsies of the liver and serum phosphatase levels, was not impaired. Serum calcium and phosphorus values were unchanged.

Depancreatized dogs, maintained on insulin and fed no lipotropic supplement, show hyperglycemia and glycosuria, and a marked hypolipemia, fatty infiltration of the liver, and evidence of impairment of the liver develop. When such animals were rendered hypothyroid, the glycosuria continued, the insulin requirement fell, the serum lipids remained low, the phosphatase high, and the fatty liver unchanged.

Raw pancreas or certain extracts of raw pancreas, when fed to the depancreatized dogs maintained on insulin, increased the daily insulin requirement, raised the plasma lipid levels to 1,200 to 1,800 mg.

per cent, lowered the serum phosphatase, and cleared the liver of fat. The effects of raw pancreas on the depancreatized dog rendered hypothyroid with radioiodine were similar. The hyperlipemia and hypercholesterolemia, however, became greatly exaggerated, total lipids rising to 2,500 to 2,900 mg. per cent and total cholesterol as high as 590 mg. per cent.

Three tables.

Saphenous Circulation Time Test with a Radioactive Tracer. Harry T. Zankel and Richard Clark. Proc. Soc. Exper. Biol. & Med. **79:** 135–138, January 1952.

A method of determining the saphenous circulation time, using radioiodine and a scintillation counter, is described, and its possible uses are indicated. The circulation time having been obtained, various physical agents can then be applied to the calf, or any other part of the body, and their possible effects on this circulation time can be obtained.

The saphenous circulation time appears to be reasonably constant for the same individual tested at intervals of five to twenty minutes. Preliminary tests show that saphenous circulation time is affected by various modalities or even by the same modality differently administered. It is hoped in the course of time to study a sufficient number of patients to permit evaluation of such modalities upon the saphenous circulation time as measured by the present technic.

One figure; 1 table.

Albumin and Globulin Circulation in Experimental Ascites. Relative Rates of Interchange between Plasma and Ascitic Fluid Studied with C^{14}-Labeled Proteins. F. W. McKee, C. L. Yuile, B. G. Lamson, and G. H. Whipple. J. Exper. Med. **95:** 161–172, Feb. 1, 1952.

Plasma containing carbon^{14}-labeled albumin and globulin, obtained by feeding ϵ-C^{14} D, L-lysine to a donor dog, was injected intravenously and intraperitoneally into recipient dogs with experimental ascites. The circulation and interchange of total plasma protein between circulating blood and ascitic fluid was confirmed and the participation of both albumin and globulin in this interchange was demonstrated.

Labeled albumin tends to reach equilibrium in plasma and ascitic fluid in a shorter period of time (one to two days) than does globulin (two or more days), after administration of labeled plasma by either route.

Evidence is presented to show that the rate of transfer of albumin across the peritoneal membrane is at least three times faster than that of globulin in terms of weight.

Two charts; 3 tables.

EFFECTS OF IRRADIATION

The Acute Radiation Syndrome: A Study of Nine Cases and a Review of the Problem. Louis H. Hempelmann, Hermann Lisco, and Joseph G. Hoffman. Ann. Int. Med. **36:** 279–510, February 1952.

This contribution, to which the *Annals of Internal Medicine* has devoted an entire number, is a report of a collaborative clinical investigation by a group from the Los Alamos Scientific Laboratory and the Argonne National Laboratory, with extremely detailed accounts of 9 cases of acute radiation syndrome occurring in the course of the Atomic Energy Program. In 2 of the patients the injuries proved fatal. Although these injuries are of the same general type as those caused by a full-scale atomic explosion, they are peculiar to nuclear reaction on a limited scale, unaccompanied by biologically significant amounts of heat and blast.

The calculated total radiation doses in terms of energy absorption ranged from 0.128 to 9.50 megagram roentgens.

The conclusion concerning the fundamental nature of the acute radiation syndrome is that widespread destruction of tissues throughout the body is the basis for the physiologic or clinical response. The destructive processes in this disease differ somewhat from those produced by other common toxic agents which originate outside the body. In the first place, the tissue damage and destruction are not confined to the surface of the body but, in the case of penetrating radiations, occur primarily in the radiosensitive tissues, wherever they are located in the body. In this third dimensional quality, as well as in its selectivity of organ damage, the acute radiation syndrome resembles certain chemical poisonings, *e.g.*, benzol, more closely than other traumatic injuries. A second peculiarity of the tissue destruction caused by ionizing radiation is that it is delayed rather than immediate, as is tissue death caused by thermal burns. Furthermore, the delay in the appearance of tissue damage varies from one organ system to another. The reason for the latent period before tissue damage becomes manifest is that the radiation doses usually responsible for the acute radiation syndrome tend to injure cells in such a way that many can survive until they attempt mitotic division. Since the mitotic activity is inhibited by radiation exposure, cell death does not occur until the tissue regains its ability to proliferate. If these peculiarities of tissue destruction are taken into consideration, the over-all clinical or constitutional response of an individual with the acute radiation syndrome is found to be similar to that observed in other diseases in which tissue death is prominent. Thus, many features of the illness of the present patients, including secondary reactions such as infection, fluid loss, and presumably the adrenal response, resemble those seen in severe thermal burns, intestinal obstruction and massive gangrene.

The conclusion regarding the state of therapy of the acute radiation syndrome is that at present one can offer only supportive therapy directed at helping the individual to survive the acute phase of the illness. Although there are a number of means by which tissues can be protected to some extent against the damaging action of penetrating radiations, there is no known method of saving doomed cells once injury has occurred. However, there is every reason to believe that the regenerative powers of most tissues are so great that considerable, if not almost complete, recovery will occur if the individual survives the critical toxic stage. In this respect, antibiotics, transfusions, and maintenance of the fluid and electrolyte balance are believed to be helpful.

Following the presentation of the cases there is a consideration of the biologic basis for the clinical re-

sponse observed and a detailed discussion of individual signs and symptoms, the hematologic changes, and the chemistry of the blood and urine.

It is impossible to do justice to this report within the limits of an abstract. It should certainly be read in the original.

Twenty-four color photographs; 29 photomicrographs and photographs in black and white; numerous charts and tables.

Acute Radiation Injuries in Man. Louis H. Hempelmann. Surg., Gynec. & Obst. **93:** 385–403, October 1951.

This paper, which attempts to present a rational basis for the understanding of acute radiation injuries in man, includes accounts of 4 cases from the files of the Los Alamos Scientific Laboratory. Three of these are included in the report abstracted immediately above, and one was previously reported by Knowlton, et al. (J.A.M.A. **141:** 239, 1949. Abst. in Radiology **55:** 475, 1950).

Radiation injuries may be classified according to the amount of the body which has been irradiated and the type of the tissue which has been damaged. Thus, there may be localized superficial injury caused by irradiation of a small portion of the body with soft ionizing radiation. There may also be generalized bodily injury due primarily to damage of internally placed radiosensitive organs resulting from exposure of a large portion of the body to penetrating radiation. All forms of injuries between these two extremes (and combinations either of the extremes or of the intermediate forms) can occur.

In addition to classifying radiation injuries according to the amount and type of tissue which has been damaged, it is necessary to consider whether or not the injury is the result of acute or protracted exposure to radiation.

One of the cases reported is an example of an acute localized injury, while 3 illustrate different degrees of severity of the acute generalized radiation syndrome, ranging from fatal injury to mild damage demonstrable only by hematologic tests.

Conclusions as to the effectiveness of treatment are those reached in the paper abstracted above.

Nine photographs; 3 hematologic charts.

Partial or Complete Pelvic Exenteration for Extensive Irradiation Necrosis of Pelvic Viscera in the Female. Alexander Brunschwig. Surg., Gynec. & Obst. **93:** 431–438, October 1951.

On the author's service in the Memorial Center for Cancer and Allied Diseases, New York, over 135 partial or complete pelvic exenterations, mostly for advanced cancer, usually primary in the cervix, have been performed. In this series there is a small group of cases in which study of the excised pelvic organs revealed no evidence of residual cancer but only extensive irradiation effects. The exenterations were all performed under the clinical impression that carcinoma was present for the following reasons: (1) It had been present at one time, positive biopsies having been obtained. (2) There were clinical findings of "frozen pelvis." (3) The patients were extremely uncomfortable, to the point of accepting pelvic exenteration for relief. Some time had elapsed since irradiation and, instead of improving, the condition of the patients was becoming worse. Partial pelvic exenteration consists of excision of the bladder, vagina, uterus, and adnexa, with implantation of ureters into the colon. In complete pelvic exenteration all pelvic viscera are removed. The ureters are implanted into the sigmoid above the colostomy and hence there is a wet colostomy, which is managed satisfactorily by means of the Pierce bag.

Eight cases of complete and 2 of partial pelvic exenteration for irradiation necrosis in the pelvis are reported. There was a total hospital mortality of 40 per cent: 1 patient died seventeen days after operation, 1 died nineteen days after operation, and 2 survived forty-four and sixty days respectively. There was one death eleven months postoperatively of self-starvation. With this one exception, once the patients reached the stage where they were able to be discharged from the hospital, they did extremely well and rapidly gained weight and returned to normal general activities. The condition of these patients was such that if operation had not been performed they would have died of complications of extensive pelvic necrosis.

Seven illustrations.

Effect of Whole-Body X-Radiation on Rat Intestine and Intestinal Nucleoprotein. Robert N. Feinstein and Carrie L. Butler. Proc. Soc. Exper. Biol. & Med. **79:** 181–182, January 1952.

After the administration of 800 r of whole-body irradiation to rats, a nucleoprotein-rich fraction of the intestine is diminished in amount and also in its content of total phosphorus, total nitrogen, dry weight, and ash. The greatest loss of phosphorus is derived from the nucleic acid fraction. In addition, the weight of the intestine, as well as the viscosity of its alkaline solutions, is significantly decreased after whole-body irradiation. These data are interpreted as substantiation of the idea that one effect of whole-body irradiation is the degradation of nucleic acid.

Two tables.

Adrenal Ascorbic Acid in Male and Female Rats after Total Body X-Ray Irradiation. B. C. Wexler, R. Pencharz, and S. F. Thomas. Proc. Soc. Exper. Biol. & Med. **79:** 183–184, January 1952.

The ascorbic acid level of the adrenals was determined in 128 male and female rats after 625 r total-body irradiation. The adrenals of the males were found to show a marked depletion of ascorbic acid after one hour. There was a rise after twelve hours, with a return to normal after forty-eight to ninety-six hours. There was no correlation between ascorbic acid and adrenal weight. Although the adrenals were larger in the females than in the males, the ascorbic acid content was less. The drop in ascorbic acid was also less precipitous in the females killed after one hour than in the corresponding males, and the return to the normal level was more rapid in the females. Another difference between the sexes was a secondary rise in ascorbic acid in the female. Repetition of the experiment yielded identical results.

One table.

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